July, 1961

The Mining Magazine

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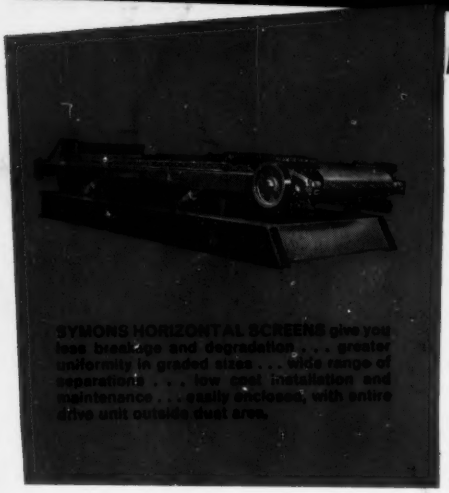

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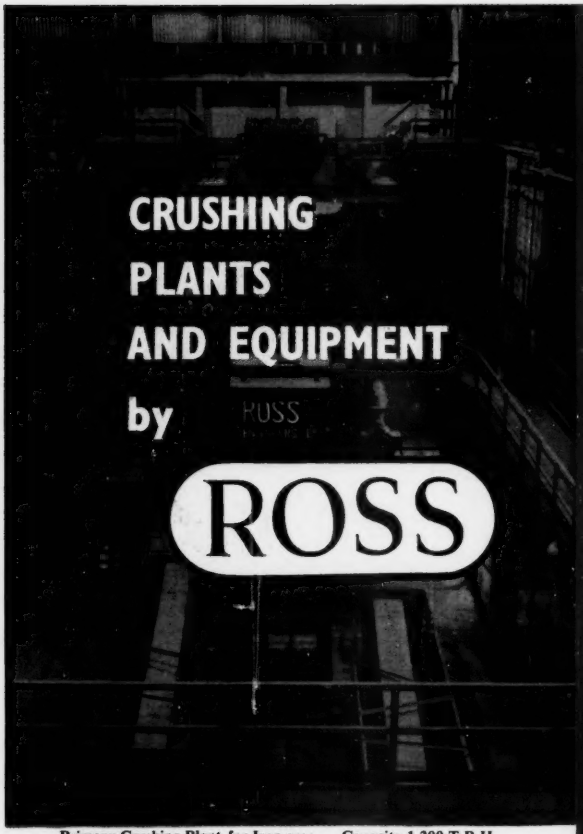

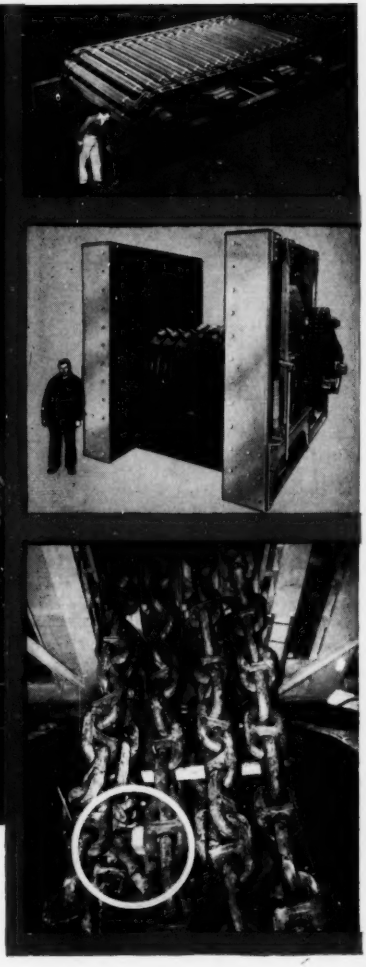

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EDITORIAL

ARRANGED by the Forschunginstitut für Aufbereitung, a meeting is to take place in Freiberg, Saxony, from August 29 to 30, to discuss the " Preparation of Non-metallic Minerals." At the time the Research Institute will be open to delegates from abroad, while visits to convenient ore-dressing plants are to be arranged for August 31. So far a series of 18 papers, all from authors on the Continent, have been arranged as a basis for discussion.

INCLUDED in the Annual Report of the Overseas Geological Surveys for 1959–60, recently released,[1] there is a note on the activities of the Overseas Mineral Processing Advisory Committee. This Committee, which consists of representatives of Overseas Geological Surveys and the Warren Spring Laboratory has recommended that priority should be given to the following of the many problems submitted to it : The recovery of monazite from the deposits at Kangankunde Hill, in Nyasaland, extraction of niobium from the deposits at Mrima Hill, in Kenya, and the beneficiation of kyanite from deposits at Ncheu, in Nyasaland. The research programmes submitted were approved by the Committee and funds have been made available, mainly by grants under the Colonial Development and Welfare Act, to enable the investigations to proceed. Preliminary investigations have also been made by the Mineral Resources Division and, in some instances, by Warren Spring, of some of the other problems submitted, but no other definite programmes of research have as yet been formulated for them. Grants totalling £20,130 have already been approved by the Treasury from Colonial Development and Welfare funds towards the cost of the investigations.

ADDRESSING the Chartered Surveyors' Annual Conference at Leicester earlier this month Mr. R. J. Cowan reviewed " Iron-Stone Workings and Land Restoration." He explained that the Mineral Workings Act, 1951, had established the Ironstone Restoration Fund under the control of the Minister of Housing and Local Government to provide money for the restoration of land worked for iron ore by open-cast methods. Local authorities had made use of the Fund to restore areas left out of agriculture as a result of ironstone workings prior to 1950 and only a very small acreage of such land is left. Since 1950 ironstone operators had restored current workings progressively to agriculture, approximately another 4,000 acres having been dealt with in this way. It was estimated that the Fund had paid out a total of £600,000 on levelling, including the spreading of top-soil and a further £200,000 in grants authorized by the Minister. In his address Mr. Cowan also spoke of the tremendous change that had taken place in the development of North-ampton sand ironstone with the introduction of modern machines and techniques over the past 30 years. Production had steadily increased to well over 8,000,000 tons annually, about half the total production of iron ore in Britain.

[1] London : H.M. Stationery Office. Price 4s.

Mining and the Future

Following the conclusion of formal business at the annual meeting of the Institution of Mining and Metallurgy held last month Mr. A. R. O. Williams was inducted as president. Mr. Williams, recently returned from the Congress in South Africa, had perforce to give much of his formal address " off the cuff," but he managed capably to roam widely over the field the modern mining industry has to cover. Speaking of developments taking place in times of change, when new ideas and new methods are constantly to the fore, he was emphatic that the greatest change of all was in the scale of modern endeavour. The base metals so important to industry were now being produced on a scale perhaps some two and a half times they were 30 years ago. Yet the new mineral elements—such as, chromium, cobalt, and aluminium—were now being turned out at vastly greater rates. While substitution had made a great deal of ground, the president said, they could not ignore the fact that the Paley report had suggested that by 1975 the United States would require minerals in vastly greater quantities than they had been needed in 1956.

In these circumstances it was in tune with the times that mining and metallurgical advances had been such as had enabled the engineer to deal with greater and greater depths and with increasingly complex ores of lower and lower grade. It behoved them to remember, however, that the future of the industry depended on more than extractive techniques. It was becoming the more important, Mr. Williams felt, to discover new ore and it was fortunate that in that connexion that the trained geologist with his geophysically-trained confrères was coming to a greater understanding of the mechanisms of ore deposition and the better able to replace the old-time prospector. As to mining itself, the president said, the airleg drill with the tungsten-carbide tipped steel, the mechanical shovel, and the rock bolt were giving the rapid advances in excavation now required, even if a nicety in sampling methods had to be kept in mind, while mineral dressing techniques were approaching the closer to automatic control. Yet, in spite of all this, the most important factor in the industry, he thought, lay in better labour relations. With that achieved the industry could work with greater efficiency and do something to regain its control of costs.

Discussing some of the delicate problems facing the mining industry Mr. Williams made reference to the growth of the big mining companies and the so-called Group system in South Africa. That system, he suggested, had certain advantages, yet it was not without its dangers. There was a danger, he felt, that too much was taken from the manager in the field, so much so that there was at times a danger to managerial control and efficiency, particularly if too much was left to the experts at head office. Again, the president said, big groups tended to neglect the smaller deposit. Many worthwhile orebodies lay in neglect owing to the fact that a group had refused to take it up. The owners of such a deposit might find it hard to raise the finance they required when such had been the case. Another disadvantage of the large house with its panel of experts had unfortunately resulted in a decrease in the number of private consultants and, as a consequence, of the advice available to one anxious for a report free of company bias. While the number of small mines had decreased, there were now many really big mines and consequently more engineers anxious to do nothing to lose pension rights, which was a pity, in more ways than one.

The president went on to point out how important it was, when a new mine was planned, that reliable cost data should be available, since forecasting had to be extremely accurate if profitable operation was to result. In his view companies might well be less frightened of releasing such data—the only data available to the estimator. Much more material of this kind might well be included in technical papers generally. Indeed engineers might well be less shy of relating their experiences in writing; such material could be of the greatest value.

Finally Mr. Williams went on to emphasize that the trained engineer will certainly be the man of the future. The " practical man," so called, was, he thought, no longer the key man in any mining enterprise. He did not consider, however, that the present was the time to talk of extended training at the mining school. Much could be done to break down the barrier between coal and metal mining and much to give the engineer a greater awareness of his fellow man and of the past history of exploration in such parts of the world he is likely to visit in pursuit of his living. This point, it will be recalled, is similar to that made by Mr. W. A. Hardy at the last Royal School of Mines dinner, as was recorded in the issue for November last. Such instruction can be of the greatest importance when work is in hand in places where nationalistic considerations are assuming greater importance.

Tin and Taxation

At one moment last month, following an attempt on the part of several Members of Parliament to have inserted a clause into the Finance Bill whereby the profits arising from the working of non-ferrous metal mines in the United Kingdom would be exempted from profits tax for 36 months from the day on which the mine was first brought into commercial operation, it appeared that metal miners had at last engaged the sympathetic ear of the Chancellor of the Exchequer. Following eloquent speeches from Mr. Harold Wilson and those of members for Cornish seats the Chancellor expressed his appreciation of the arguments expounded and said that, while promising nothing, he was prepared to look into the matter and see whether there was any way in which he could " help by some further kind of tax concession." The reference was of course to the fact that

in the Treasury view the metal-mining industry is already favoured by " a substantial tax holiday."

The hopes raised were not, however, to be realized. Speaking later on the new clause Sir Edward Boyle, Financial Secretary to the Treasury, said that the Chancellor had not found it possible to authorize a concession, although he " was in full agreement with the thesis that the fullest practicable use should be made of mineral resources." So, it seems, we are back where we were and pleading must start again !

South African Mining

In his presidential address to the annual general meeting of the Transvaal and Orange Free State Chamber of Mines last month Mr. C. B. Anderson referred to the manner in which the relationship between South Africa and the world had changed. As a first result of South Africa's departure from the Commonwealth there had been large-scale selling of investments and indications that capital for the financing of new ventures might not be forthcoming from its traditional sources. As a corollary, he said, there could now be a tendency for ore reserves to be depleted faster than they could be replaced by the opening up of new mining ground, particularly as the industry was already drawing largely from its own resources to finance development. However, he considered that the decline in favour of gold mining in South Africa as a sphere of investment was, on the economic facts, unwarranted and that large-scale investment should be as amply rewarded as it had been in the past. World demand for gold was as eager as ever, he said, and they were continuing to mine it with increasing efficiency and in ever-increasing quantities.

Following the customary review of the industry Mr. Anderson referred to the visit of the Seventh Commonwealth Congress and said that delegates attending must have taken away with them a clear picture of the contribution that mining had made to the advance of civilization in South Africa and of the great potential that existed for future development. The withdrawal of South Africa from the Commonwealth had been followed by the conditions of economic stress already referred to and he thought it the prime duty of the authorities to restore faith in the country's ability to solve its problems in a rational and peaceable way. Various steps had been taken to halt the country's decline in reserves and to strengthen its balance of payments, he said, but such measures as import and currency controls and the restriction of credit supply could only be palliatives, while more drastic forms of control, such as the recent embargo on the repatriation abroad of the proceeds of sales of securities, could only further weaken confidence in the country as a sphere of investment. He was, however, hopeful of the days that lay ahead. South Africa was the only really industrialized bulwark of Western civilization on the Dark Continent and they should not underestimate the advantage for the future that rested in the location of the Witwatersrand and the vast industrial complex that had sprung up around it. He thought the universal demand for gold imparted equilibrium to the South African economy and, whatever the future might bring, that demand would remain a stabilizing factor of prime importance.

Cornish Engines Preservation Society

It will be recalled that the Cornish Engines Preservation Society was formed about 25 years ago in order to co-ordinate efforts being made to keep a few of the old steam engines then extant in existence. From its inception the chairman of the Society was the late Mr. A. T. Holman, himself a Cornish engineer of distinction. It had for long been Mr. Holman's ambition that the Society should gain possession of what has been described as the most celebrated of the surviving examples, the 80-in. engine at the Robinson's shaft at South Crofty. That engine has recently been presented to the Society by its owners and it is felt right that it should be preserved in its own engine house at the mine near Camborne. Unfortunately it seems much will have to be done to restore both housing and engine and an appeal has been launched for £1,500 to enable this to be done.

The Society, it may be recalled, took possession of the Deeds of Conveyance of the 90-in. engine, known as Taylor's engine, at East Pool. The cost of that purchase was born by a generous donor in the United States. The £1,500 required to preserve the Robinson engine might well come from British interests, particularly as it is felt that the success of the appeal would form a fitting tribute to Mr. Holman.

MONTHLY REVIEW

Introduction.—With stocks of tin tending to shrink while those of other base metals increase prices show a natural correspondence. Business confidence neverthless, in spite of pressure on sterling and the uneasy state of international dealings, still appears quietly confident.

Transvaal.—The gold return figures for the Rand and O.F.S. mines for May show a production of 1,885,415 oz., making with 42,062 oz. from outside mines a total of 1,927,447 oz. for the month, a new record. The number of natives at work in the gold mines at the end of May was 396,437, as compared with 398,012 at April 30 last.

The table below shows dividends declared by the Rand mining companies for the past half-year.

	2nd half, 1959	1st half, 1960	2nd half, 1960	1st half, 1961
	s. d.	s. d.	s. d.	cents
Blyvooruitzicht (2s. 6d.)	1 2	1 3	1 3·6	13
Brakpan (3d.)*	0 6	0 4½	0 6	5
Buffelsfontein (10s.)	1 9	1 10½	1 9	17½
City Deep	0 7½	0 7½	0 8·4	7
Consolidated Main Reef	1 3	1 6	1 6	15
Consolidated Murchison (5s.)	5 6	3 6	4 3	30
Crown Mines (10s.)	2 0	2 0	2 0	20
Daggafontein (5s.)	2 3	2 0	2 0	20
Dominion Reefs (5s.)	1 6	1 6	1 3	15
Doornfontein (10s.)	1 6	1 6	1 4·8	13
Durban R'dpoort D'p (10s.)	1 6	1 6	1 6	15
East Champ d'Or (2s. 6d.)	0 3	0 3	0 3	2
East Daggafontein (10s.)	0 7½	0 7½	0 7½	7½
East Geduld (4s.)	1 11	1 8	1 9·6	15
East Rand Prop. (10s.)	1 9	1 9	1 6	10
Eastern Rand Ext. (5s.)	1 0	0 9	1 0	7½
Eastern Transvaal Consol. (5s.)	0 1½	0 3	—	—
Geduld Prop.	5 0	3 4	3 7·2	30
Government Areas (3d.)*	—	—	0 3	3½
Grootvlei Prop. (5s.)	1 5	1 1	1 4·8	11
Hartebeestfontein (10s.)	3 0	3 0	2 6	25
Libanon (10s.)	0 3½	0 4½	0 4·8	5
Luipaards Vlei (2s.)	1 0	1 0	1 0	10
Marievale Consolidated (10s.)	1 7	1 6	1 10·8	15
Middle Wits. (2s. 6d.)	0 7½	0 7½	0 7·5	—
Modderfontein B. (3d.)	0 6	—	0 6	—
Modderfontein East	1 0	0 6	0 6	5
New Klerksdorp (5s.)	1 0	1 3	1 7	35
New Pioneer Central Rand (5s.)	1 3	1 9	1 6	17½
Rand Leases (3d.)*	1 0	—	—	5
Randfontein	2 3	1 3	1 9	17½
Rietfontein Cons. (3d.)*	0 8	0 6	0 7·2	2
Robinson Deep (3d.)*	—	—	—	2½
Rose Deep (3d.)	—	—	1 0	—
South African Land (3s. 6d.)	0 6	0 6	0 6	5
South Roodepoort M.R. (10s.)	1 1½	1 1½	1 1·5	11½
Southern Van Ryn	0 7	—	0 7·2	—
Springs Mines (5d.)*	0 6	—	0 6	—
Stilfontein (5s.)	1 7½	1 6	1 6	15
Sub Nigel (3d.)*	1 3	1 3	1 3	12½
Vaal Reefs (5s.)	2 0	1 6	2 0	17½
Van Dyk Consolidated (3d.)*	—	—	—	7½
Venterspost (10s.)	0 10½	1 0	1 0	10
Vlakfontein (10s.)	1 0	0 11	1 1·2	10
Vogelstruisbult (3d.)*	0 10	0 8	0 8·4	5
West Driefontein (10s.)	4 9	2 7½	2 10·8	31
West Rand, Ord. (10s.)	2 3	2 0	2 3	17½
Western Reefs (5s.)	1 3	1 3	1 3	12½
Witwatersrand Nigel (2s. 6d.)	—	0 1½	—	1·2

* Capital Repayment.

A circular to shareholders of WAVERLEY GOLD MINES last month stated that while operations for the year to June 30, 1960, were conducted at a loss, results for the first three quarters of the current year showed an operating profit of R9,512. However, the circular states, at the beginning of the fourth quarter a movement of the foot-wall occurred to the east of Main shaft, causing serious caving between 1 and 5 Levels east of the shaft, a major fall of hanging on 5 Level west of the shaft, the blockage of the main ore pass from 5 to 3 Levels, and a loss of working faces. A week later further falls of hanging occurred at West shaft. Tonnage for April was seriously affected. Although immediate steps were taken to re-open the caved drives and to commence equipping Main shaft from 8 to 12 Levels with a view to supplementing ore for the mill, the position has not yet been fully recovered. In all the circumstances the Company has given the statutory three months' notice, in terms of the Gold Law, of the possible discontinuance of mining operations. Efforts to open up additional mining areas within the property, particularly below 9 Level at both the Main and Glenluce shafts, and to get the mine back to a payable scale of operations, are to be continued.

Speaking at the annual meeting of the CENTRAL MINING AND INVESTMENT CORPORATION held in Johannesburg earlier this month the chairman, Sir Archibald Forbes, reporting a profit of £2,448,000 before taxation, reminded shareholders of the two important changes that had taken place in the capital structure of the Corporation at the end of the financial year. Approval has been given to arrangements whereby preference shares issued were cancelled, the holders receiving as consideration 250,000 ordinary shares. At the same time voting rights were restored to foreign shareholders and approval was also given to the capitalization of £4,250,000 of the Corporation's reserves through the issue of one ordinary share of £1 credited as fully paid. As a result of these arrangements the issued share capital of the Corporation is now £8,500,000 all in ordinary £1 shares. He suggested that, taken as a whole, the operation of the mines of the Central Mining-Rand Mines Group in 1960 were satisfactory. Production of gold rose slightly to 3,890,000 oz. Working profit on gold rose by £69,000 to £13,070,000 and on uranium by £640,000

to £4,740,000. The net improvement during the year, he said, was attributable to the Blyvooruitzicht and Harmony mines, there being some falling off at certain of the older mines.

HENDERSON'S TRANSVAAL ESTATES reports a profit of £139,409 for the year ended March 31 last, the accounts showing £274,404 available. Of this dividends equal to 10½d. a share require £98,092, while £19,848 has been placed to reserve, leaving £156,464 to be carried forward.

Orange Free State.—Results obtained in Borehole S.P.8 on the Farm Stuirmanspar, situated approximately 6,200 ft. south-south-east of No. 2 shaft and 3,500 ft. due east of Borehole S.P.7 have been reported by PRESIDENT BRAND GOLD MINING. The hole intersected the Basal Reef at a depth of 6,801 ft., assaying 14·5 dwt. of gold per ton over a width of 34 in. Two deflections were made subsequently, the first at 6,799 ft. assaying 12·8 dwt. of gold per ton over a width of 31½ in., and the second, at 6,799 ft., assaying 7·4 dwt. of gold per ton over a width of 38½ in.

Diamonds.—Net sales of diamonds for the three months to June 30 have been reported by DE BEERS CONSOLIDATED MINES as £21,742,917, making a total of £46,045,168 for the first half-year.

It has been announced that the off-shore diamond deposits along South-West Africa's diamond coast are to be worked again. A company including American interests, the MARINE DIAMOND CORPORATION, has been registered to exploit the concession area, which stretches 190 miles up the coast from the Orange River to Luderitzbucht. It was recently ascertained by the South African Appeal Court that the concession extends from the low-water mark to three miles out to sea. Because of this, methods employed to recover the diamonds will include frogmen.

Southern Rhodesia.—It is reported that mining operations have begun at the Alaska mine near Sinoia belonging to MESSINA (TRANSVAAL) DEVELOPMENT. For the time being ore is being won opencast, although underground mining is to be carried out at a later date. Concentrates from the mine will be processed at the Alaska smelter of MESSINA RHODESIAN SMELTING AND REFINING.

The Department of Mines has reported that during 1960 numerous inquiries were received from Japanese industrialists for supplies of iron ore. In most cases only the sale or lease of local properties were offered and the only concern to take up such an offer was the Kobe Steel Works who then began drilling operations on a deposit at Hunters Road. Options were taken over claims in the Midlands by MINES DE CHROME S.A., Lausanne, and by the end of the year preparations were also in hand for the shipment of trial lots of iron ore to Japan from claims near Que Que and Fort Victoria.

A new concern—the MATSUO RHODESIA MINING COMPANY (PRIVATE), LTD.—a connexion of the MATSUO MINING COMPANY of Tokyo, was registered in Salisbury during April and is understood to have purchased mineral rights covering tantalum and beryllium deposits.

It was recently announced by the LONDON AND RHODESIAN MINING AND LAND CO. that negotiations are in hand with a view to the acquisition of certain assets controlled by Mr. R. W. Rowland in Rhodesia which include a majority interest in MASHABA GOLD MINES (PVT.) and a substantial interest in KANYEMBA GOLD MINES. Other interests include the NORTON DEVELOPMENT COMPANY and CONSOLIDATED HOLDINGS, both interested in the motor-car industry.

In the period from November 1 last to May 31 sales of movable assets by MOTAPA GOLD MINING realized £10,576. In a circular to members it is stated that all assets have now been disposed of with the exception of a number of blocks of mining claims for which a purchaser is still being sought. If no sale is concluded in the near future the claims are to be abandoned. Some difficulty is being experienced in collecting certain debts and this has prolonged the winding up of the company's affairs. In the circumstances a second interim distribution of 3d. a share will be made " in the near future."

Northern Rhodesia.—With the recent dividend notice shareholders of NCHANGA CONSOLIDATED COPPER MINES were informed that the profit for the year to March 31 last is £12,450,128, of which dividends require £9,800,000.

Nigeria.—NARAGUTA KARAMA AREAS reports a profit of £1,570 for 1960, the accounts showing a credit balance of £3,495 carried forward. The ore production for the year amounted to 117 tons.

Sierra Leone.—It is reported that the new mill of the SIERRA LEONE DEVELOPMENT COMPANY was recently started at Marampa. It is expected to step up production at the mines from 1,500,000 tons to 2,000,000 tons

of iron ore per year. Plans are already in hand for a further mill to be completed by 1964 and it is probable that the port of Pepel will have to be expanded to handle the greater production planned.

Liberia.—Reference to the LAMCO JOINT VENTURE ENTERPRISE was made in the May issue. The company's accounts were recently published in Stockholm and according to them considerable progress was made in 1960. It will be recalled that operations at the Nimba mine are scheduled to start in 1963. For the project all procurement and construction work is handled by the GRÄNGESBERG COMPANY, which has established a special Liberia department. Contracts have been concluded for the building of the port at Lower Buchanan, the railway to the Nimba mine, and roads in the mining district. Work on the 250-km. railway from Lower Buchanan to Nimba commenced in May, 1960, and by the end of the year half the distance had been cleared for construction to start. A road-building programme, including over 160 km. of roads, was completed.

Australia.—Elsewhere in this issue our correspondent in Melbourne refers to an aluminium enterprise set up by the ALUMINUM CO. OF AMERICA and a consortium of Australian mining companies. In a statement last month the Commonwealth Minister for National Development, Senator the Hon. W. H. Spooner, welcomed the development, which, he said, would be based on Western Australian deposits of bauxite and the extensive brown coal deposits near Anglesea, in Victoria. The proposal, coupled with that of the CONSOLIDATED ZINC-KAISER group through COMALCO INDUSTRIES, PTY., LTD., in developing aluminium production at Bell Bay in Tasmania, offered, he thought, promise of the establishment of a major group of industries in Australia. At the same time the Western Australian Government has concluded an agreement with WESTERN ALUMINIUM, LTD. (offshoot of the WESTERN MINING CORPORATION) for the setting up of an alumina plant at Kwinana, near Fremantle. Three years of work has been put in to the development of the amount and analysis of the Darling Range bauxites.

The report of SONS OF GWALIA, LTD., for 1960 shows a profit of £1,621 and a credit balance of £54,662 carried forward. In the year the company milled 156,025 tons of ore and recovered 33,083 oz. of gold. At December 31 last the ore reserves were estimated to be 241,110 tons, of an average grade of 4·94 dwt. per ton.

Malaya.—IDRIS HYDRAULIC TIN reports a profit of £45,124 for 1960, the accounts showing £65,004 available, of which dividends equal to 1s. 6d. a share require £44,100. In the year 803,000 cu. yd. of ground was treated and 273 tons of tin ore recovered. Following the annual meeting on July 12 shareholders were to be asked to approve of the capitalization of £32,000 from revenue reserves, to be used in paying up 320,000 new shares of 2s. each, to be issued credited as fully paid in the proportion of one new share for every three shares held.

An extraordinary meeting of AMPAT TIN DREDGING is to be held early next month and shareholders will be asked to approve that the capital be reduced to £62,500 by a return of 3s. on each 4s. share issued and a reduction of the share value to 1s. Thereafter it is proposed to increase the capital to £250,000 again by the creation of 3,750,000 new 1s. shares.

TANJONG TIN DREDGING reports a profit of £186,822 for 1960, £187,808 of the £210,001 available having been distributed as dividends, equal to 4s. 1½d. a share. The output of tin ore for the year totalled 725 tons, recovered from 2,301,900 cu. yd. dredged.

Burma.—In the three months to March 31 last the BURMA CORPORATION (1951), LTD., mined 33,784 tons of concentrating ore and produced 4,023 tons of refined lead, in addition to 351,559 oz. of doré silver, 41 tons of copper matte, 13 tons of zinc speiss, and 3,717 tons of zinc concentrates. The operating profit for the period is given as K4,45,800 and that for the nine months to the same date as K2,22,700. The accounts for the nine months show a net loss of K8,16,900 (£61,268). The report for the quarter states that the dismantling of No. 1 winder at Marmion Shaft and work in connexion with renewing its foundation commenced early in April. Subject to there being no unforeseen difficulties encountered it is hoped that the winder will be in operation well within the estimated period of six months. When it is again working every endeavour is to be made to increase ore production.

The operations of the ANGLO-BURMA TIN COMPANY in the year to April 5 last resulted in a profit of £3,870. In the year to September 30 last the joint venture company produced 339 tons of ore and made a profit

of £3,339, the debit balance brought in being thereby reduced to £11,717.

Colombia.—During 1960 the six dredges of PATO CONSOLIDATED GOLD DREDGING handled 23,274,000 cu. yd. of gravel and recovered 86,222 oz. of gold. Operations resulted in a profit of $506,143. Two dividends each of 10 cents a share were paid in 1960, the $700,500 required being charged to surplus, which now stands at $522,859. At December 31 last workable gravel reserves totalled 424,704,000 cu. yd. averaging 15·5 cents per yd., in addition to 225,375,000 cu. yd. of ground averaging 10 cents a yard. The partnership company in Brazil—EXPLORACAO DE MINERIOS BRASILIA—is intensifying exploration, concentrating its efforts on four areas, with the interest mainly centred on diamonds, gold, and beryllium. Two diamond-bearing areas are being test-pitted and drilled, while a scout-drilling programme is underway on a central Brazilian river to prospect gold-bearing alluvials. A programme for exploration and small-scale testing work on beryl-bearing pegmatites in eastern Brazil is also being undertaken.

DIVIDENDS DECLARED

*Interim. †Final.

(Less Tax unless otherwise stated.)

African and European Investment Co.—Pref. 3%, payable Aug. 15.

***Amalgamated Collieries of South Africa.**—15 cents, payable Aug. 15.

†**Angola Diamond.**—Esc. 59.

***Apex Mines.**—17½ cents, payable Aug. 8.

†**Aramayo Mines in Bolivia.**—4%.

***Ashanti Goldfields Corporation.**—1s., payable Sept. 13.

***Ayer Hitam Tin Dredging.**—7½d., payable Aug. 4.

***Berjuntai Tin Dredging.**—1s., payable July 19.

†**Central South African Lands and Mines.**—6d.

†**Charterland and General.**—10% and 8% bonus.

Consolidated Diamond Mines of South-West Africa.—Pref. 3¾%, *Ord. 50 cents, payable Aug. 15.

***Coronation Collieries.**—5 cents, payable Aug. 15.

De Beers Consolidated Mines.—Pref. R1, payable July 28.

***English China Clay.**—2½%, free of tax, payable July 12.

***Fresnillo Co.**—20 cents, payable July 17.

†**Idris Hydraulic Tin.**—1½d., payable July 14.

***Kepong Dredging Co.**—1s., payable Aug. 1.

***Malayan Tin Dredging.**—9d., payable July 27.

†**Natal Coal Exploration Co.**—2½ cents, payable Aug. 15.

†**Nchanga Consolidated Copper Mines.**—5s. 6d. payable Aug. 25.

†**Phoenix Colliery.**—10 cents, payable Aug. 8.

***Rand Mines.**—25 cents, payable Aug. 8.

***Rooiberg Minerals Development Co.**—35 cents, payable Aug. 8.

†**South African Coal Estates (Witbank).**—30 cents, payable Aug. 15.

***Southern Malayan Tin Dredging.**—1s. 3d., payable July 24.

***Springbok Colliery.**—7½ cents, payable Aug. 15.

†**Tanjong Tin Dredging.**—6d., payable Aug. 26.

†**Transvaal Consolidated Land and Exploration Co.**—23 cents, payable Aug. 8.

***Transvaal Navigation Collieries.**—6 cents, payable July 29.

***Tweefontein United Collieries.**—6¼ cents, payable July 1.

***Vereeniging Estates.**—30 cents, payable Aug. 17.

†**Vierfontein Colliery.**—5 cents, payable Aug. 15.

***Vryheid Coronation.**—3¾ cents, payable Aug. 15.

†**Welgedacht Exploration Co.**—4 cents, payable Aug. 8.

West Rand Consolidated Mines.—Def. R9·916, payable Aug. 8.

†**West Witwatersrand Areas.**—20 cents, payable Aug. 8.

Western Mining Corporation.—6d., Aust., payable Aug. 17.

†**Zaaiplaats Tin Mining.**—32½%, payable Sept. 9.

METAL PRICES

July 10.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	230	0	0
Chromium (98%–99%)		7	2½
Nickel (Home)	660	0	0
Platinum (Refined)	30	5	0
Silver		6	7⅜
Gold	12	11	11
Wolfram (U.K.)		—	
(World)	6	10	6

Tin, Copper, Lead, Zinc — See Table, p. 48

Blending Glassy Materials

A. E. Williams, Ph.D., F.C.S.

Preparation of frit for use as a protective material

Introduction

The inert nature of glass is the main reason for the adoption of somewhat similar compositions in the form of protective coatings for more vulnerable materials. Frit is used, for example, for the protection of pottery, masonry coatings to protect brickwork, stone, concrete, etc. Such compositions contain many ingredients, often including colouring materials, and they are generally of a complex character. Frit, which is applied to earthenware and china in the form of a glaze, renders the porous clay non-porous. It enhances the appearance of the article coated, increases its life, and makes it non-absorbent. Without the protective coating pottery would not be suitable to contain foodstuffs, for it could not be cleaned efficiently.

An elementary grade of frit can be made from a mixture of silica and soda ash, but it would be very limited in its applications. To extend its usefulness it is necessary to build around the basic materials—silica and soda ash—a complicated structure to meet the requirements of different kinds of pottery manufacture. Materials so added include felspar, borax, nepheline syenite, fluorspar, alumina, etc.

The addition of felspar gives the frit manufacturer three ingredients at once, an alkali, alumina, and silica. It is often employed on account of its pure alumina content, since the price of felspar is much less than that of high-grade alumina ; it enables raw materials cost to be kept down. Even more ingredients are obtained by the use of nepheline syenite, for in addition to alumina and silica this mineral can introduce oxides of iron, calcium, magnesium, sodium, and potassium. In the Western world the main source of supply of nepheline syenite is Canada, where, at Lakefield, Ontario, it supplies a mixture of felspars containing about 22% of felspathoid nepheline. It can be cleansed by magnetic

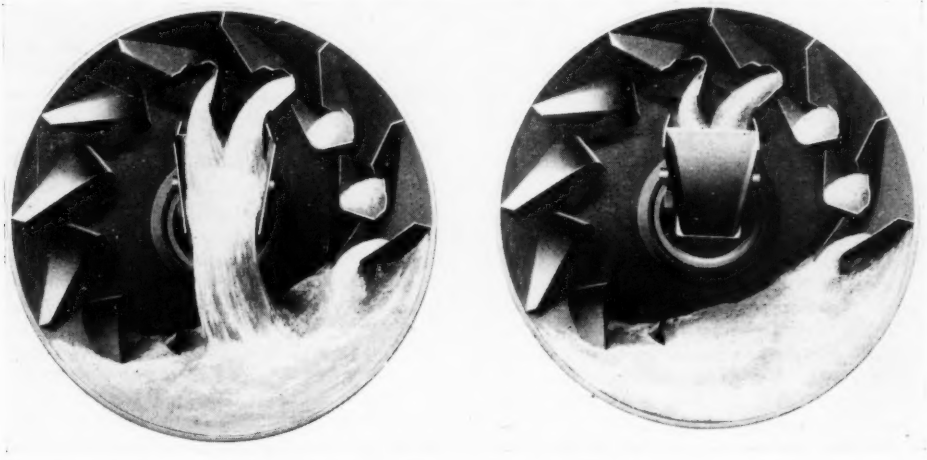


Fig. 1.—Blender at Work : Left, receiving ; right, discharging.

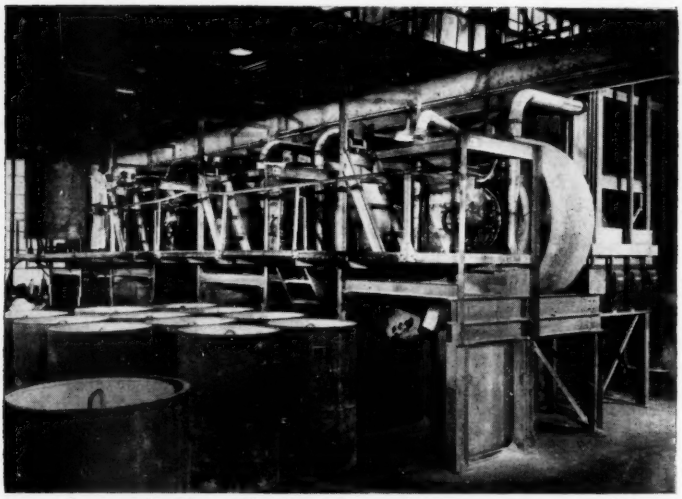


Fig. 2.— Four-Batch Blender in a U.S. Mill.

and electrical separators and a suitable mixture for use in frit is obtained by this means.

The main function of alumina in frit is to increase the mechanical strength of the applied glaze and to prevent minute cracks appearing in the glaze after a period in service. The frit manufacturer achieves this end by the use of either felspar or nepheline syenite. Which of the two he uses is determined largely by the grade of frit to be made, taking into consideration the higher alkali content of nepheline syenite and the high silica content of felspar. Where the ingredients of felspar and nepheline syenite are not required in the mix, the frit maker can still impart strength to his products by using alumina. The latter material is now produced in large tonnages, its production being particularly an intermediate stage in the preparation of aluminium from bauxite ores.

Boron compounds such as borax, boric acid, and borates are used in frits for glazes which have to withstand elevated temperatures. The boron compounds do this by modifying the rate of expansion and contraction when the article carrying the glaze is heated or cooled. Where a specially high gloss is required on the glazed article, coupled with a resistance to heat, a metallic borate, such as cadmium or zinc borate, is employed. Generally speaking boric acid imparts a higher strength to the glaze than is possible with borax, although both impart about the same heat-resistance properties.

Fluorspar is a convenient substance for the introduction of fluorine into the glaze, this element serving to create an opalescent effect in the glaze as well as improving the melting rate. The pure mineral contains about 97% of calcium fluoride, CaF_2. As an alternative to fluorspar the mineral cryolite, Na_3AlF_6, may be employed, but as natural supplies are obtainable only from one mine, at Ivigtut, in Greenland, a lot of it used in frit is produced synthetically. With the development of nuclear power within the past decade a demand has arisen for the use of lead in frit and this metal may be introduced in the form of litharge. Articles glazed with lead-containing frit give greater shielding power against radiation. Many other substances are employed in frit formulations to impart specific properties and these include phosphates of ammonia and soda, titanium dioxide, nitrate of soda, etc.

Some of the minerals and chemicals are used only in very small proportions and as the applied glaze is only a very thin film it follows that success or failure depends almost entirely on the degree to which the different substances can be uniformly distributed. A glaze would fail if only a minute area of the applied surface lacked its share of the essential ingredients. Success in a frit manufactory is, therefore, achieved only by careful formulation to suit a particular application and the means of carrying this formulation into the finished product.

Blending Method

In the United States the problem of intimately blending the various constituents of frit has been solved by making use of a

device that has met with much success in other industries whenever a blending problem presented itself. This ingenious machine is the rotary batch blender, developed by the Sturtevant Mill Co., of Boston, Massachusetts. In this unit the powders to be blended are passed into the drum of the blender, where they are immediately taken up by a series of scoops (Fig. 1) which carry the material to the top of the blending chamber and cascade it into the revolving drum. This cascading and revolving of materials is supplemented by the forcing, without separation, of the multiple ingredients from both ends of the blending drum to the middle. In this way the blender achieves a four-way blending action, circular, vertical, and two lateral movements.

A typical frit manufacturing firm using this method of blending is the Pemco Corporation, of Baltimore, claimed to be the world's largest producers of various grades of frit. The throughput in this plant (Fig. 2) amounts to 180,000 lb. daily. Ingredients which are employed in large quantities are received in bulk railway cars and transferred to storage bins by belt-conveyor. From the bins they are weighed into a batch tank which will hold a total of approximately 1,800 lb., which may be made up of many different ingredients. Other materials which are not used in large quantities are received at the plant in bags. From these bags the required amount is weighed out and added to the bulk materials in the batch tank, so that the tank ultimately contains the whole of a particular formulation but in the unblended state. With the large output maintained at this plant the method of blending has to be quick and efficient.

A few years ago the Pemco management discarded ribbon mixers, which had been in for some time, in favour of the rotary batch blenders. These operate on 8-min. cycles, the ingredients being fed to the blenders from the batch tanks. In adopting this type of blending the Pemco organization has improved the quality of the products, besides lessening downtime for cleaning and maintenance to the point where only routine lubrication is needed to keep the blenders operating at peak efficiency. Before the installation of these units a change in formulation involved careful brushing and cleaning of the ribbon mixers to prevent one batch contaminating another. With the present arrangement, simply by running out the powders, the blenders are clean enough to handle almost any other batch. However, whenever there is a remote possibility of

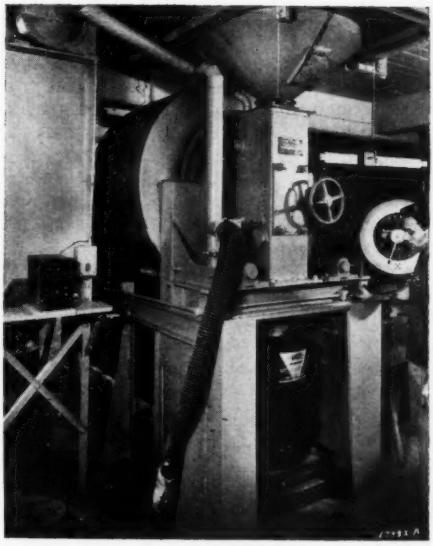


Fig. 3.—Rotary Batch Blender of 25 cu. ft. Capacity.

contamination occurring, a load of neutralizing silica is passed through the blenders in an abbreviated cycle ; when this is discharged the blenders are ready for any sensitive batch to follow. A plate on the front of each blender is easily removed to give quick access to the interior of the unit when required.

Furnace Treatment

From the blenders the batches are taken to a battery of eight continuous furnaces, or smelters ; one rotary batch blender being able to supply two furnaces. In the furnaces the various materials in the blended batch are melted and fused together, the internal temperatures ranging between 2,000° F. and 2,400° F., according to the fusing points of the materials being treated. Operating temperatures are carefully controlled and recorded automatically. In addition, an extra check is provided by the use of radiation pyrometers, whereby radiated heat from the smelter is focused on a thermo-junction coupled to a galvanometer, the deflection of which gives the approximate temperature of the smelter.

As the materials melt they assume the form of a liquid glass and move to the lip of the smelter at a temperature of approximately 1,800° F. This glass-like stream is

then passed through two water-cooled rollers which compress it to a thin sheet of about 0·0030 in. thickness. This passes by gravity down a chute which feeds a coarse roll unit. The product from this is further crushed to yield the final product in the form of small flakes, which are then dried and bagged for shipment.

A sample is taken from the continuous smelting furnaces every hour and is checked for opacity, degree of fusion, colour, and other factors such as consistency and uniformity. In addition to this routine testing in the laboratory the incoming raw materials are examined, while in the research section investigations are carried out with a view to improving still more the quality of the finished products, particularly with reference to colour, opacity, and durability. Both raw and finished materials are analysed and recorded by spectrographic analysis. Expansion characteristics are recorded by interferometric measurement, while an X-ray diffraction unit produces identification patterns of crystalline materials.

Ceramic Auxiliaries

In many ceramic articles the colour of the base material is not so important as the colour of the external surface and the latter is applied separately, after the essential article has been prepared, by colouring, glazing, and firing. With such techniques it is not difficult to obtain colour consistency, for the colour merely has to be uniform on the outer surface. There are, however, certain ceramic auxiliaries which must possess an accurate nuance of colour throughout their mass, for these materials are not afterwards treated in any way to obtain colour consistency. Examples of these are ceramic tile adhesives and jointing and coloured coatings for masonry. In tiling work it is just as important that the thin lines of material between the tiles should be of uniform colour, as that colour consistency must be preserved on the tile surfaces themselves. Similarly, in preparing a coating for application to masonry to enhance the appearance and to protect the surface, the object has not been achieved if any colour variations exist in the applied coating. These coatings are now also applied to the mass production of concrete blocks having a coloured outer surface.

The essential difference between these ceramic auxiliaries and a piece of coloured pottery, for example, is that the latter has been produced in two main operations—the production of the uncoloured unglazed article, followed by the application of colouring and glazing. These two operations involve three separate blendings, clay, colour, and glaze. On the other hand, a ceramic auxiliary has to be produced in one single blending and all the required ingredients, including colour, must be blended together in one operation, so that the ultimate user can proceed to apply the material without being burdened with any further blending. Of the many ingredients which go to make up a ceramic auxiliary—basic material, solvent, binder, hardener, etc.—the colouring matter is often the lowest in quantity and may well be under 1% of the whole batch, but it is vitally important that the colour be evenly distributed.

At the Upco Company's plant in Cleveland, Ohio, where a range of these auxiliaries is made, the problem of obtaining an accurate blend in their various products was always to the fore until early in 1955, when their method of blending was changed from ribbon blending to rotary batch blending. The modern unit they have installed is a Sturtevant 25 cu. ft. capacity rotary blender (Fig. 3). This unit replaced four ribbon-type blenders and incidentally much space in the workroom was saved at the same time. The weight of batch the blender will take at a time varies, of course, with the density of the material, but an average batch is 2,200 lb. and consists of six or more ingredients. The blender is driven by a 7½-h.p. motor and the actual blending time to secure a uniform product is 4 min. or, including filling and discharging time, 10 min. Compared with this the ribbon blender used to take 30 min. for the blending operation.

The blender receives the materials from a weigh hopper which feeds directly into the blender and the blended product may be discharged directly into drums which are then weighed; alternatively, it may be passed from the blender to an adjacent silo. Should a following product be of a different colour the blender is generally cleaned out by introducing a small amount of quartz, but if a dark-coloured batch has to be followed by a light-coloured one the blender may be swept out or suction cleaned. This is accomplished by opening a gasketed manhole which allows access to all internal parts. Total clean-out time at the Upco plant averages less than one day per month, although the firm blends seven major different coloured materials.

Iron Production Methods in Current Development

Notes on certain alternative methods of oxide reduction

W. H. Dennis, B.Sc., M.I.M.M.

Introduction

Although the blast-furnace is the most important and widely-used furnace for the production of iron for steelmaking, considerable effort has been devoted throughout the world to developing alternatives to the orthodox blast-furnace operation. The large output required for economic operation coupled with the enormous cost of new blast-furnaces (£10,000,000, say, including coke ovens), together with the requirement for high-grade metallurgical coke, has led to a search for alternative methods based on reduction in the quantity and quality of coking coal or its substitute by other fuels—such as oil and natural gas. Further, the development of smaller-scale methods requiring less capital permits the installation of iron works in underdeveloped areas where large-scale markets do not exist, when adequate transportation facilities are lacking, or where iron-ore deposits and fuel and energy sources, although available, are not on a scale sufficient to support large-scale operation.

Direct Reduction of Iron.—In the majority of these alternative processes iron ore is converted to iron in the solid state, the iron never attaining a molten condition as in the blast-furnace, such operation being known as direct reduction. Strictly speaking "direct" reduction should refer only to direct reduction of oxide ore by carbon, hence "direct reduction" is in reality an incorrect term, as it is widely used to denote non-blast furnace reduction. However, from wide usage the term is firmly entrenched.

Rotary-Kiln Processes

Krupp-Renn.—The Krupp-Renn process was developed in Germany and has been in commercial operation in that country and elsewhere since 1939. It was extensively operated during the war when Germany to a large extent was cut off from imported high-grade ore.

The process, which in reality is a pyrometallurgical beneficiation process, uses low-grade silicious ores that cannot be economically beneficiated by other methods. A solid reducing fuel is used, inferior coals with a high ash being capable of utilization. Reduction of ore is carried out in a rotary kiln (Fig. 1)

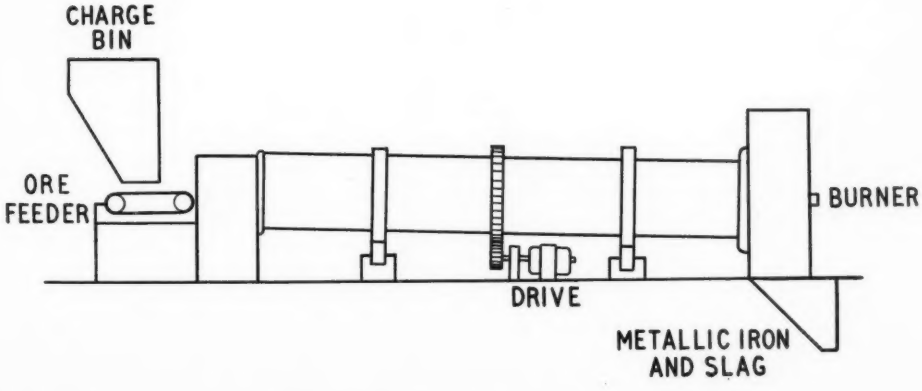


Fig. 1.—Krupp-Renn Rotary Kiln.

inclined at a small angle, heating being applied at the lower end by a burner supplied with pulverized coal. As the mixture of ore and carbonaceous matter travels down the kiln its temperature gradually rises, reduction by carbon monoxide commencing at about 600° C. When a temperature of 1,100° C. has been reached additional heat is introduced to achieve a final reduction temperature of 1,250° C.

The iron never becomes molten, remaining dispersed in the form of nodules in a viscous slag which discharges at the lower end of the kiln. The product is cooled with water sprays, crushed, and freed from associated slag by magnetic separation. Fuel requirements include pulverized coal at 8% to 10% and coke breeze at 25% of the weight of ore. An assay of the products from one such operation is given in Table 1. A disadvantage of the process is that most of the sulphur and phosphorus in the charge goes into the iron which therefore cannot be used to make steel direct, the concentrate usually being charged to blast-furnaces. Kilns up to 350 ft. in length and 15 ft. in diameter are in use in Germany, Spain, and Japan.

Table 1

Composition of Products from Krupp-Renn Process

Product.	*Composition per cent.*						
	Fe	SiO_2	Al_2O_3	*CaO + MgO*	*S*	*P*	*C*
Ore	30	27·5	11·0	3·5	0·3	0·5	—
Metal	93·5	—	—	—	0·7	1·5	0·6
Slag	0·4	60·2	25·0	13·0	—	—	—

R-N Process.—The R-N process, which originated in the U.S.A., resembles the Krupp-Renn process in that the reduction is carried out in a rotating kiln. The use, however, of limestone and a lower reduction temperature gives a product of much lower sulphur and phosphorous content than the Krupp process. The ore, sized to 1 in., carbonaceous matter (coke breeze or anthracite fines), and limestone are fed to a rotary kiln fired with gas or oil. Reduction takes place at a temperature of 1,000° C. to 1,100° C., which is well below the melting point of substantially all the constituents of the charge. The materials discharged from the kiln are cooled and separated by screening, gravity, or magnetic means, the metallized product being pressed into briquettes which can be used as feed to open-hearth or electric furnaces. The excess carbon is cleaned, dewatered, and returned to the kiln for re-use. It is claimed that both magnetic and non-magnetic ores having a wide range of iron content may be treated to yield a product containing about 90% metallic iron at a recovery of 90%. The process derives its name from the initial letters of the two companies who have developed it—the Republic Steel Corporation and the National Lead Company.

Strategic-Udy Process.—The Strategic-Udy method invented by Dr. Udy and developed in the United States by Strategic Materials

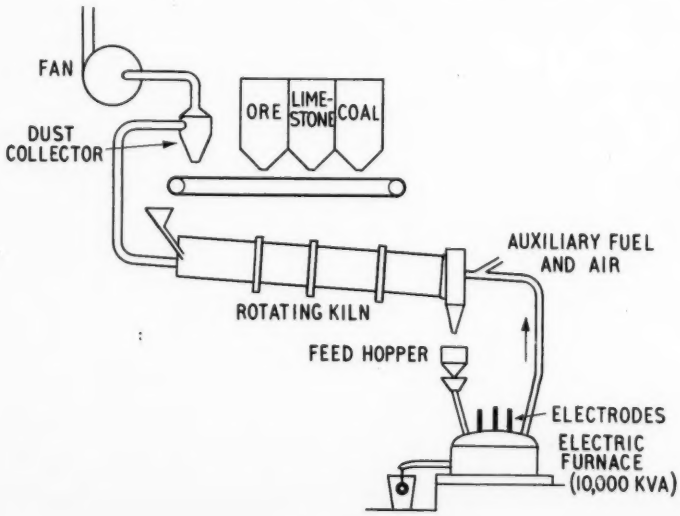


Fig. 2.—Strategic-Udy Process.

Corporation, combines the use of a rotary kiln and an electric furnace (Fig. 2).[1] Only a partial reduction of the ore takes place in the kiln, a substantial part of the heat required being supplied by burning the carbon monoxide produced from completing the reduction reaction in the electric furnace. Iron ore, limestone, and carbonaceous reductant are fed to the kiln, the temperature being controlled within the range 1,100° C. to 1,300° C. Beyond this temperature the free flow of the product is impeded, the hot charge commencing to cake and adhere to the walls of the kiln. The product from the kiln drops into the electric furnace in which reduction is completed. It is claimed that the partial reduction of ore before it is fed to the electric furnace cuts the power required by half and also makes possible the use of complex ores now of little value and not suitable for the blast-furnace.

Sponge Iron

If iron ore is reduced in the solid state with a reducing gas such as carbon monoxide or hydrogen, metallic iron is obtained in a spongy porous mass. According to the type of equipment used to effect the reduction, the process may be divided into fluidized-bed reactors and fixed-bed reactors.

Fluidized Bed

Fluidization may be defined as a heat-treatment method in which finely-divided solids are maintained in partial suspension in an upwardly moving stream of air or gas. It has the effect of making a bed of solids behave somewhat like a fluid which is being violently aerated. It possesses the advantage of intimate contact between the reducing gas and solid, thus ensuring a high conversion efficiency.

H-Iron Process.—The H-Iron process is an American method in which preheated finely-divided high-grade iron ore is fed to a reducing vessel under high pressure (500 p.s.i.) where it is reduced to iron by hydrogen passing through the bed of ore at a temperature of 480° C. The comparatively low reduction temperature ensures that the particles of charge and product do not become tacky and therefore do not adhere together. The high pressure is advantageous in that a high reaction rate is achieved, the reduction taking place in steps, $Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow Fe$, thus avoiding the slow reaction, $FeO \rightarrow Fe$.

[1] GRINDROD, J. Iron by Direct Reduction. THE MINING MAGAZINE, Feb., 1959.

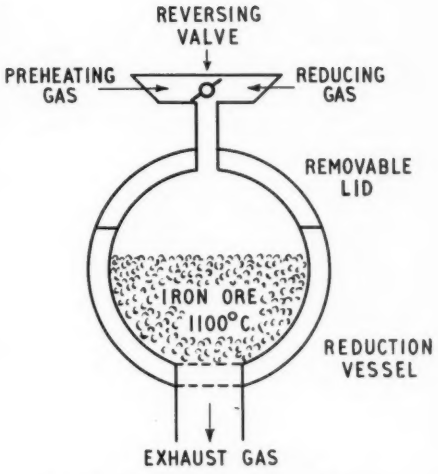


Fig. 3.—Diagram of the Hyl Process.

Hematite and magnetite ores can be used equally well, but an ore of high iron content must be used, since none of the gangue is removed during the reduction. The finely-divided iron becomes pyrophoric during the process and hence a finishing treatment has to be given in which the iron is heated to 850° C. and cooled under an inert nitrogen atmosphere to passivate it.

Fixed Bed

In this type of reactor the bed is fixed, reducing gases being blown through the ore contained on the bed.

Hyl Process.—The Hyl process is operated by the Hojalata y Lamina Company, a leading Mexican steel producer, and was designed to produce sponge iron to substitute for scrap in short supply.

Ore in the form of lumps, sinter, or pellets is charged to the reduction vessel (Fig. 3), hot gases being blown through to preheat it to 1,100° C. The reductant is a hot mixture of hydrogen and carbon monoxide produced by catalytic steam reforming of natural gas ($CH_4 + H_2O \rightarrow CO + 3H_2$). It is a batch process.

Hojanas Process.—In the Swedish Hojanas process, which is both the simplest and oldest of the common direct-reduction methods, rich ore (70% Fe) together with coal fines or coke breeze and limestone is charged into cylindrical ceramic containers known as

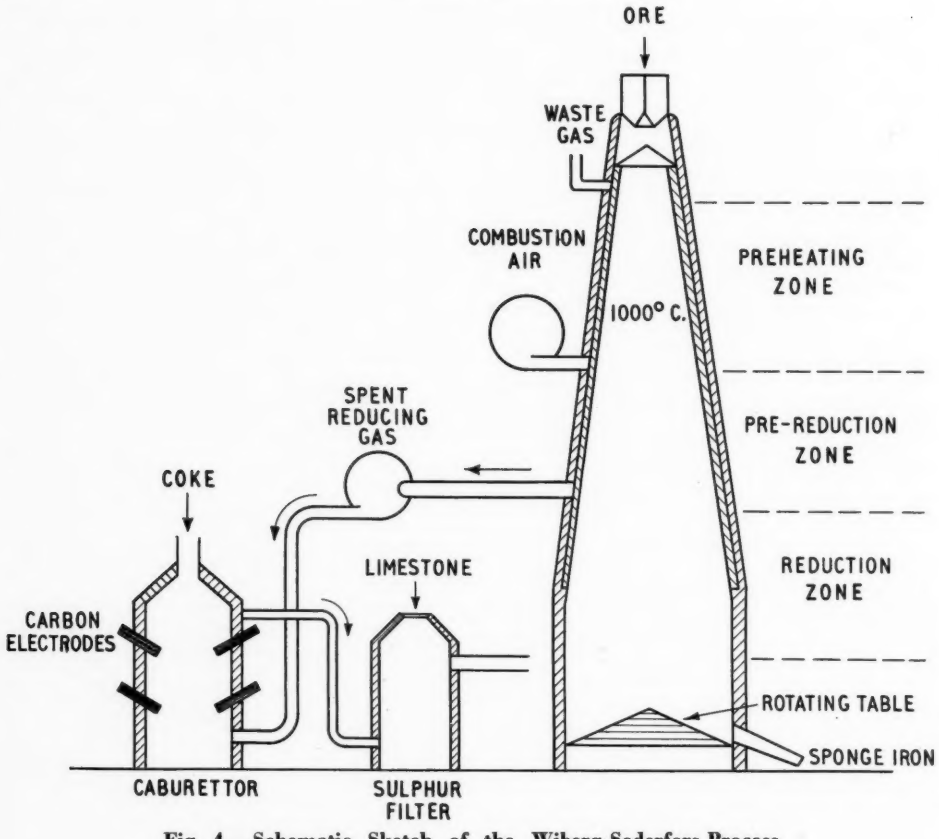


Fig. 4.—Schematic Sketch of the Wiberg-Soderfors Process.

" saggars " and heated to temperatures of 1,200° C. in a tunnel furnace of the type used for burning bricks. Carbon monoxide produced by the reduction of the ore with the carbonaceous material escapes from the containers being burnt outside them, thus supplying part of the heat needed for reduction. After cooling the containers are removed from the furnace and emptied. The iron, which has sintered together into porous cakes, is cleaned from adhering ash, any unburnt carbonaceous matter being recirculated. The total treatment time including charging and discharging from the furnace is about 10 days.

The sponge iron contains about 87% iron and 0·01% to 0·02 % sulphur, the degree of reduction being 96%. It is used chiefly for making steel in the open-hearth or electric furnace.

Wiberg-Soderfors Process.—The Wiberg-Soderfors method for the gaseous reduction of iron ore uses carbon monoxide and hydrogen as the reducing agent. The furnaces used in Sweden are all of the vertical shaft type (Fig. 4) operating with lump ore or sinter. The ore is preheated in the upper part of the furnace and then reduced at a temperature of 900° C. in two stages in the middle and lower parts of the shaft, reduction to ferrous oxide taking place in the former, the subsequent reduction to iron occurring in the lower portion. About two-thirds of the stack gas is withdrawn from the furnace and blown through a mass of coke or charcoal in an electrically-heated gas producer (carburettor) where carbon dioxide and water vapour react with the carbon in the coke, providing a mixture of carbon monoxide and hydrogen required for the reduction of the ore in the shaft. The sponge iron is cooled in the lowest part of the shaft and continuously discharged

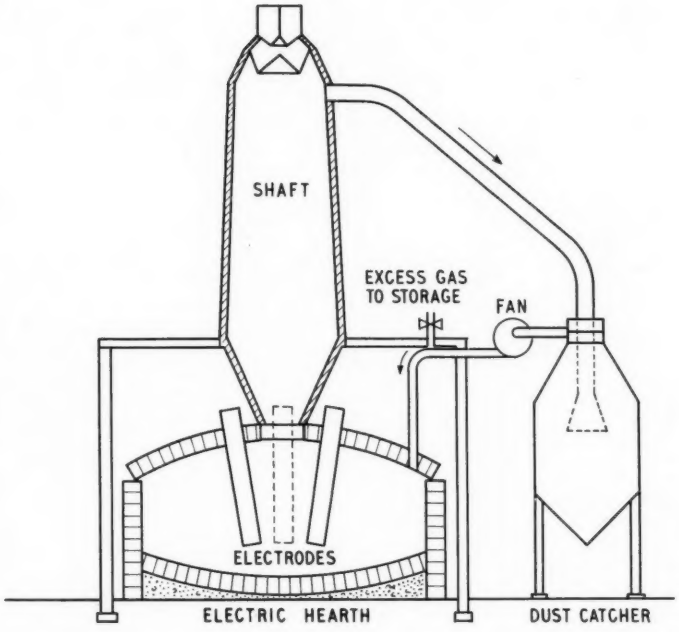


Fig. 5.—Electrometall Furnace.

from the furnace by a rotating table. The reduction with carbon monoxide is exothermal and that with hydrogen is endothermal and the proportion of these gases (75% CO, 25% H) is so chosen that the heat produced in the first reaction just compensates for that absorbed in the second reaction. A minimum of external heating is thus achieved and in fact the process has the lowest fuel consumption of all pyrometallurgical iron-making processes, the coke consumption being about 0·25 ton per ton of sponge iron. Sulphur in the fuel which is gasified in the carburettor is largely absorbed in a limestone filter installed between the carburettor and the furnace.

Six of these plants are operating in Sweden producing about 150,000 tons of sponge iron per year. Sponge iron finds use in various industrial processes other than in the manufacture of steel. Since it is usually of high purity it is used in the chemical industry as a reducing agent and in production of small components by the method of powder metallurgy in which the powdered metal, moulded to the desired shape, is compacted at high pressures and then sintered in the temperature range 980° C. to 1,100° C.

Electric Smelting

In countries where blast-furnace fuels are expensive, but where cheap electric power can be obtained, the use of electric smelting furnaces has been found economical. There are two main types of electric furnace for the production of pig-iron, the " Electrometall " furnace and the " Tysland-Hole ".

Electrometall Furnace.—The Electrometall furnace (Fig. 5) was developed in Sweden and consists of a shaft superimposed over a melting chamber which is heated by electrodes inserted through the roof. Ore and charcoal are charged to the shaft, the carbon monoxide produced by the direct reduction of the ore with carbon in the melting chamber prereducing the ore in the shaft. The reduced iron gravitates to the smelting chamber, where refining takes place. Since heat is supplied electrically, the charcoal acts only as a reducing agent.

The quantity of gas produced in the melting chamber is only about one-fifth of that produced in an ordinary blast-furnace and is therefore insufficient for heating the ore in the shaft to suitable reduction temperatures. A certain amount of gas is therefore recirculated from the top of the shaft to the melting chamber

in order to increase the quantity of gas in the shaft. Electrometall furnaces are built in small units for about 4,500 kW, producing 50 tons of pig-iron per day.

Tysland-Hole Furnace.—The main difference between the Tysland-Hole and the Electrometall furnaces is that the Tysland-Hole has no shaft for the prereduction of the ore with gas. The furnace consists of a melting chamber with three vertical electrodes of the Soderberg self-baking type inserted through the roof. There are also openings in the roof for charging the burden and venting of gas. Coke is used as reducing agent instead of charcoal. Consumption of carbon electrodes and electrical energy are considerably higher than in the Electrometall furnace, coke consumption per ton of pig-iron being about 900 lb. and power consumption 3,000 kWh. The output of a 10,000-kW furnace is about 100 tons of pig-iron per day.

Dwight-Lloyd McWare Process.—This process, which has been under development by the Dwight-Lloyd Sintering Company, is essentially an electric furnace smelting technique operating on sintered ore. Finely-divided iron ore, low-grade fuel, and limestone are intimately mixed and then pelletized, the pellets then being distributed to a Dwight-Lloyd sintering machine. Because of the intimate mixing, sintering causes a 40% to 60% reduction of the oxide ore to metallic iron. These prereduced pellets are then charged to an electric-arc furnace when final reduction occurs, pig-iron and slag being tapped off. The process is extremely rapid, the time taken to travel from the ore-bin to the electric furnace taking only 15 min.

Conclusions

Summing up, it would appear that of the many alternative processes for iron production only a relatively few have stood the test of time. Even those that have been placed in commercial operation have only a limited use and in the foreseeable future it is unlikely that there will be any serious rival to the orthodox blast-furnace as a mass producer of iron for steelmaking. Modifications in operational procedure may be expected, but revolutionary changes in the design of the blast-furnace are unlikely.

Bibliography

ROGERS, R. R. Canadian Mines Branch Circular 1 C 109 (1959) Direct Reduction of Iron.

"Resources for Freedom." Vol. 4. U.S. Govt. Printing Office, Washington.

"Direct Reduction of Iron Ore." *Engg. Min. J.*, Dec., 1960.

The Witwatersrand Controversy [1]

A final comment on the review [3] by Professor C. F. Davidson

Paul Ramdohr [2]

Es kann der Brävste nicht in Frieden leben,
wenn es dem bösen Nachbarn nicht gefällt !
SCHILLER, "Wilhelm Tell."

"Freedom of creed" should apply to geological opinions as well as for religious matters. Thus, if someone considers himself in a position to provide explanations for the genesis of an ore deposit because of reasons which he thinks are right, and if he can stand criticism, he should do so. If this were all, Professor Davidson might well explain the Witwatersrand ores as formed by hydrothermal activity, lateral secretion, or even by meteroritic action, without necessitating any reply and one could pass on to more important business. But a reply becomes necessary if the logical views of a representative of a different creed are mispresented or modified by omissions or additions or if attempts are made to ridicule.

In my second paper on the Witwatersrand there is an anomaly, inasmuch as it appears that it was submitted for publication two years before it was published. It is evident from the context that there was a misprint

[1] Translated by E. F. STUMPFL, University College, London.

[2] Heidelberg; at present at the Geophysical Laboratory, Washington, D.C.

[3] THE MINING MAGAZINE, Feb., Mar., Apr., 1960.

on the copyright and licence-page—1957 appearing instead of 1958. At the beginning of the text it is stated that the work was based partly on material which I collected during my second visit to South Africa and Professor Davidson knows that this second visit took place in the spring of 1957. Many of my underground mine visits were undertaken in the company of his former co-worker, Dr. S. H. U. Bowie.

In the English version of my first Witwatersrand paper the German word "Geröll" [1] has been translated to "pebble." (It may well be that this translation is generally difficult and does not give the full meaning, but what is meant is evident from both the German and the English text. It seems strange and even amusing that I am to be taught what the *German* word "Geröll" means and that by reference to a Russian book.)

In dozens, if not hundreds, of cases my presentation, or that of Liebenberg, Nel, and many others, has been altered by alterations of words and sense. These range from small sense-changing nuances such as "*the* essential constituent" instead of "*an*"—to important alterations—such as the deletion of "not" in important position—or, even worse, by pointing to alleged neglect on my part of papers on age determination ("all these researches, however, are ignored"), whereas literature (Nicolaysen, for example) one or two years succeeding my paper is cited. The fact that the geologic age is not of much importance for detailed aspects of my investigations (except the general statement "very old") and that I, giving absolute age values in approximate figures expressly refer to data provided by L. H. Ahrens as the *most reliable* ones at the time of my investigations, are completely omitted. (To give these approximate age figures seemed desirable for introducing the reader not acquainted with the matter). Professor Davidson knows as well as I do that all age values for *very old* rocks have had to be corrected considerably during the past five years. He knows, moreover, that the different methods (K–Ar, Rb–Sr, Pb–U, etc.) give values which can hardly be compared and that, finally, and this applies especially to the Witwatersrand area, the widely used Pb–ages show such a variation that comparisons can be made only with utmost circumspection. Microscopic evidence shows that uraninite grains have partly lost, partly gained Pb, and that uranium in places and at some time has been taken into solution by hydrocarbons to form thucholite. During such processes selective migration of U, Pb, decay products, and, possibly, lead isotopes took place. Finally, the "Pronto reaction"—exactly as in the Blind River area—led at some time to the formation of a mineral of independent age and necessarily resulted in providing "mixed ages." Such sources of error have been recognized, but it seems to be extremely difficult to apply those in a quantitative way for the correction of age values.

I discovered the "Pronto reaction" during my investigations on material from the Pronto mine. The reaction is to be observed in the same form in specimens from Milliken, Consolidated Denison, Algom-Nordic, and other mines in the Elliot Lake District, as well as in specimens from the Dominion Reefs, and in some case, from the Witwatersrand System. Dr. Kaiman did not succeed, when he first tried, in performing this reaction synthetically. As we have shown, the reaction $2\ TiO_2 + UO_2 \rightarrow UTi_2O_6$ takes place readily and completely when a flux is used. My pupil, Ö. Öztunali, published our findings in an easily-accessible journal prior to Kaiman's paper. Dr. Davidson could have synthezised brannerite within 24 hours using our procedure. Using fluxes we have obtained the reaction down to 400° C. and it certainly takes place at even lower temperatures.

Dr. Davidson doubts—for the second time—my having recognized uraninite in Witwatersrand ores as early as 1928. The duplicate of the observation note concerned, written about 1928, is in the polished sections files of the Mineralogy Department, Aachen Technical University, which I left in the winter semester 1933–34. By a mere coincidence these files escaped a fire which destroyed the department—so there is no obstacle for Dr. Davidson to inspect the files himself.

I present illustrations and mention, extremely carefully, that in some Black Reef pyrite and in carbonaceous matter from the Blind River District I have found textures which show *similarity* to bacteria textures. Of this Davidson says: "Truly the banket is a lapis mirabilis, for it yields evidence of ancient non-oxidizing atmospheres, the earliest forms of life, and strange departures from the law of gravity. No philosopher's

[1] In German the word "Geröll" refers to form and geological provenance only and not to size.—Translator.

stone of mediaeval alchemists produced a bigger crop of miracles." However, Professor Elso Barghoorn, of Harvard, a leading specialist on questions concerning the oldest plant life, writes to me as follows :—

" I was greatly interested in your microphotograph, which most assuredly shows organic structures in the Witwatersrand rocks. Also the other photo from the Blind River deposits shows all the appearances of organic structure."

As far as the " non-oxidizing atmosphere " is concerned I always expressed myself with the utmost caution in matters of genetical explanations. P. Eskola, in the Brouwer Memorial Volume, discusses the possibility and probability of an atmosphere at first rich in CH_4, and later rich in CO_2. However, not only Eskola, in Finland, but v. Engelhardt (2) [1] in Germany, Rutten (3) in Holland, and several colleagues in Russia have arrived at the conclusion, based on different methods of approach, that the principle of actualism in its very conservative version, cannot be applied to the very oldest times. All I did, on the other hand, was to suggest care and to indicate a possible " expansion of this idea by analogy with the nearest planets."

Dr. Davidson writes—I am " relatively unacquainted with uranium mineralizations." It may be that some people, amongst them Davidson, have seen *more* deposits. But here, thoroughness matters a bit, also. One could only wish Dr. Davidson had seen less but observed more. The rounded, but nearly always oval grains of uraninite on the Witwatersrand have an appearance completely different from the various forms of colloidal pitchblende. Dr. Davidson's reference to the tiny uranium pebbles observed by Mittempergher and others is completely out of context. First, they are throughout much smaller than the Witwatersrand pebbles ; secondly, their history is completely different—in good polished sections under high power magnification it can be seen that they originally have been pyrite bacteria (or, according to Love, very primitive fungi). These have been replaced in all possible stages—first in their organic coticules, then in the pyrite.

In regard to Prof. Davidson's comment on a " few polished sections of ore fortuitously collected . . ." I have visited 17 mines (some of them several times) and have material from many others, all together about two-thirds of a ton and about 400 polished sections. I know that it is not enough, but of course one does not want to damage the mines' production figures.

The observation of pyrrhotite formed from pyrite pebbles in the Ventersdorp Contact Reef is also denoted because I did not give illustrations on this particular point and did not mention the detailed locality. The suite of specimens in question comes from the South Roodepoort mine and was collected in part by Mr. Buchmann from Florida, Transvaal, and in part by my assistant, Dr. E. Stumpfl, who took samples from the very contact region. In that zone, at temperatures below the melting point of granite, pyrite is changed into pyrrhotite, as is well known.

From Prof. Davidson's pamphlet I have just picked a few points which represent strong attacks on me. But even from those I have omitted some remarks which might even be interpreted as deliberate insults. To discuss in detail hundreds of misquotations and wrong conclusions would take me and any reader too much time and the journal too much space. In the future I will not enter discussion of any of Davidson's statements—a point of view which is held already by many of my South African friends. Besides, as indicated on earlier occasions, I am ready to show my rich material to anyone interested in the subject. I am sure that everybody concerned with the problems will easily be convinced.

[1] A short bibliography is given at the end of this note.

Literature

(1) Öztunali Ö. " Über die Struktur von Brannerit." Neues Jb. Miner. Mh., 1959, S. 187–188.

(2) v. Engelhardt W. from : " Kreislauf und Entwicklung in der Geschichte der Erdrinde." p. 97 :—

" The most important changes of the atmosphere concern carbon oxide and oxygen. The original atmosphere of the earth certainly contained no free oxygen, as the primary magmas and rocks are under-saturated in oxygen and would have re-absorbed any available oxygen . . ."—and later : " is in agreement . . . with the assumption that all oxygen has been formed by the activity of green plants."

(3) Rutten, M. G. " Origin of life on Earth, its Evolution and Actualism." *Evolution* 11, 56–59, 1957.

Here it says for instance : " First in an atmosphere and hydrosphere which consists mainly of NH_4O and H_2S photochemical reactions . . . have developed large quantities of " organic " compounds . . . . A third step consists . . . of microbic life . . . photosynthesis in the system of H_2S and CO_2, . . . final step . . . by which free oxygen was produced . . . The present oxygenic atmosphere only dates from that time. . . ." This change he considers as having started gradually 2×10^9 years ago and continued until about 1×10^9 years ago. The first beginning of " real " life he dates back to at least $2{\cdot}7 \times 10^9$ years—which is in best coincidence with what Eskola and the biologists say.

Only a few words about the latter :—

Unfortunately I came across the most modern internationally accepted biological and biochemical publications on the origin of life in semi-popular representations only now, for example D. L. Arnon in California (" The role of of light in photo-synthesis ") " There is a good deal of evidence, that when life came on earth, the atmosphere contained little oxygen but did contain free hydrogen gas," or Earl A. Evans in Chicago (" How life began ") " The principal constituents of the primitive atmosphere were hydrogen, ammonia, methane, and water. The most notable difference was the absence of free oxygen . . . all evidence indicates that the life originated in the absence of oxygen." The same in G. Gamow and A. I. Oparin, Moscow, (" The origin of life "). They all lead to exactly the same conclusions on the atmospheres of the earth in very old times as the publications of astronomers, geologists, and mineralogists that I quoted. Finally Davidson has only to read the excellent, even if slightly lurid special edition of the journal *Life* " The world we live in," 1955, to see the principle of actualism from a more modern point of view.

Determination of Small Quantities of Tin and Copper

P. G. Curtis, A.C.S.M.

A combined method applicable to soils and sediments.

Introduction

Methods so far in use for determining tin and copper necessitate individual treatment of separate soil fractions for each of the metals. In geochemical prospecting it is common to determine values for both metals and therefore any means of reducing the number of analytical operations is welcome.

The methods at present most commonly in use are, first, Wood's method for determining total tin, and modifications thereof (Stanton and McDonald, 1961.),[1] and, secondly, Stanton's method for determining total copper (Stanton, 1958). By these methods samples to be analysed for tin require a preliminary fusion with ammonium iodide, whilst those to be assayed for copper have to be fused with potassium bisulphate. In the method described here each sample is fused with ammonium iodide and copper and tin are determined on aliquots of the leachate. Thus a considerable saving in time is achieved.

[1] References are given at the end of the article.

Method

(1) Weigh 1 g. of the *minus* 80-mesh (BSS) fraction into a Pyrex tube (18 × 180 mm.).

(2) Add 1 g. powdered ammonium iodide and mix.

(3) Fuse gently so that as little as possible of the sublimate is lost.

(4) Leach with 10 ml. of 0·5N HCl.

(5) Warm gently, rub down sides of tube with polythene rod, and allow residue to settle.

(6) Pipette *two* 1-ml. aliquots into *separate* tubes and use one for the determination of tin and the other for copper.

(*A*) *Tin* :

(7) Make up one of the aliquots from step 6 to 5 ml. with tin buffer.

(8) Warm to dispel the colour ; allow to cool completely.

(9) Add 0·2 ml. gallein-methylene blue solution ; mix and leave for 3 min.

(10) Compare with standards.

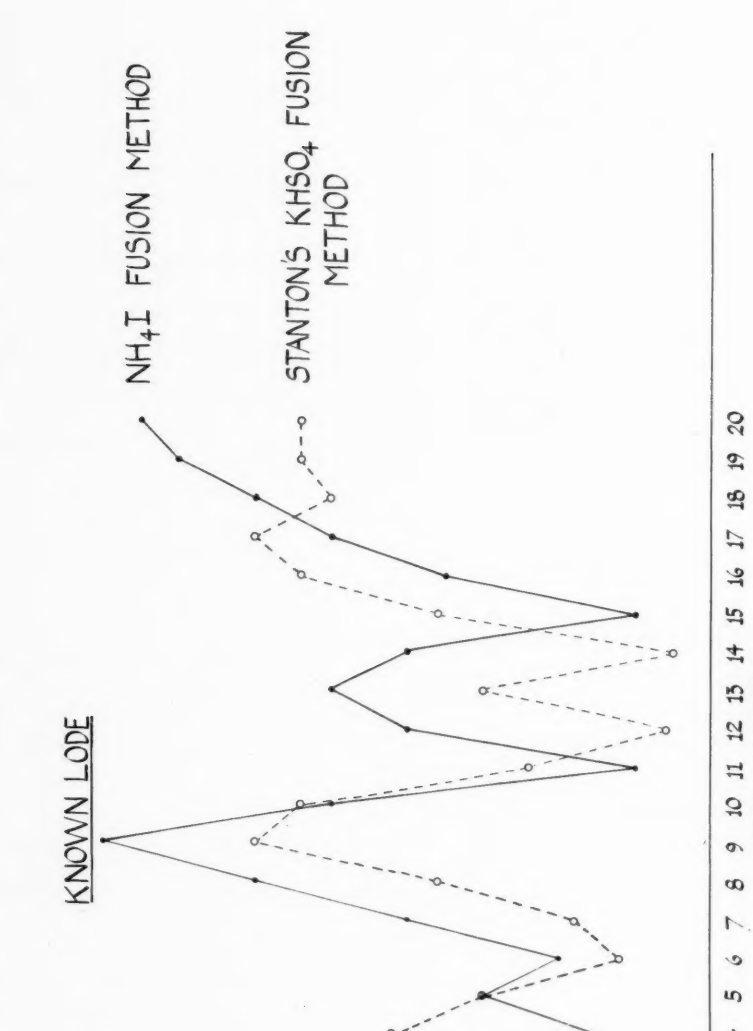

PPM COPPER
400
300
200
100
KNOWN LODE
NH4I FUSION METHOD
STANTON'S KHSO4 FUSION METHOD
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
SAMPLE NUMBERS
SAMPLE INTERVAL:- 10ft.
MATERIAL ANALYZED :- MINUS 80-MESH FRACTION FROM THE B HORIZON

Fig. 1.—Graphs showing the Distribution of Copper : Determined by Stanton's method and that of the writer, taken along a N-S Traverse on the Northern Flank of Carn Brae, Cornwall.

(*B*) *Copper* :

(11) Make up the other aliquot from step 6 to 5 ml. with copper buffer. Warm until almost colourless and cool.

(12) Make up to 10 ml. with 0·001% solution of dithizone in benzene.

(13) Shake for two minutes and allow to settle.

(14) Compare with standards.

Standards :

Tin.

(1) To 10 test tubes add respectively 0, 0·1, 0·2, 0·3, 0·4, 0·5, 0·6, 0·7 0·8, 0·9, and 1·0 ml. of a standard solution containing 5μg. of tin per ml.

(2) To each of the first 5 tubes only add 0·5 ml. of 0·5N HCl.

(3) Dilute to 5 ml. with tin buffer.

(4) Add 0·2 ml. gallein-methylene blue solution.

(5) Mix and allow to stand for 10 min. before using.

Stability of the standards can be extended to about two weeks by the addition of 0·1 ml. of a 1% gelatine solution between steps 2 and 3 (Stanton and McDonald, 1961) or 0·1 ml. of a 0·5% solution of Polycell (author).[1] The keeping time is slightly better when using Polycell, but standards should be left for 30 min. before use.

Copper.

(1) To 10 test tubes add respectively 0, 0·5, 1·0, 1·5, 2·0, 2·5, 3·0, 3·5, 4·0, and 4·5μg. Cu.

(2) Make up 5 ml. with copper buffer.

(3) Add 5 ml. of 0·001% dithizone in benzene. Shake for 2 min.

Reagents.

(*A*) *Tin* :

Buffer :—Dissolve 0·25 g. gelatine in 100 ml. hot water and add it to a solution of 50 g. chloroacetic acid, 50 g. sodium chloroacetate, and 25 g. hydroxylamine hydrochloride in 300 ml. of water. Dilute to 500 ml.

Gallein-methylene blue solution :—Dissolve 40 mg. methylene blue in 250 ml. of water. Dissolve 100 mg. gallein in 100 ml. absolute ethyl alchohol and filter through Whatman No. 1 filter paper. Mix equal volumes of the two solutions.

Tin standard solution :—Dissolve 50 mg. of tin (A.R.) in 50 ml. conc. HCl and dilute to 500 ml. with water. Dilute 5 ml. of this solution to 100 ml. just before use.

[1] Polycell is a proprietary brand of water-soluble cellulose.

(*B*) *Copper* :

Buffer :—Dissolve 100 g. ammonium citrate and 100 g. hydroxylamine hydrochloride in 500 ml. water. Dilute to 1 litre. Wash the solution free of copper by shaking vigorously with successive 15 ml. portions of 0·1% dithizone-chloroform solution. Wash solution free of dithizone with 15 ml. portions of chloroform. Store in a polythene bottle.

Dithizone stock solution :—Prepare 50 ml. of a 0·2% w/v solution of dithizone in chloroform. Store in a thermos flask.

Dithizone-benzene solution :—Dilute 1 ml. of the stock solution with 200 ml. benzene.

Standard copper solution :—Dissolve 200 mg. of $CuSO_4.5H_2O$ in metal free water. Add 5 ml. of conc. HCl and dilute to 500 ml. One ml. of this solution contains 100 micrograms of copper, and may be kept for long periods. Dilute 5 ml. of this solution to 100 ml. (1 ml. contains 5 μg. of copper).

The accompanying graphs show the p.p.m. copper obtained by two different methods (one of which is the proposed modification) in certain *minus* 80 mesh (BSS) fractions from the B horizon soil samples taken along a north–south traverse on the northern flank of the Carn Brea granite ridge.

The results obtained by each of the two methods yield graphs, which although not identical, agree so far as the positions of the anomalies are concerned, and so, from the point of view of geochemical exploration, are equally satisfactory.

The modification enables c. 60 tin *and* copper determinations to be made per 8-hour man-day in contrast to the 80 tin *or* copper determinations which can be achieved if a separate soil fraction is used for each element.

Work is at present continuing on the use of the ammonium iodide leachate for the determination of total zinc.

Fig. 1.—Graphs showing the Distribution of Copper : Determined by Stanton's method and that of the writer, taken along a N-S Traverse on the Northern Flank of Carn Brae, Cornwall.

MATERIAL ANALYZED :- MINUS 80-MESH FRACTION FROM THE B HORIZON

References

STANTON, R. E., and MCDONALD, ALISON J. " The field determination of tin in geochemical soil and stream sediment surveys. (*in the Press*).

STANTON, R. E., and GILBERT, M. A. " Analytical procedures employed at the Geochemical Prospecting Research Centre at Imperial College, London " (Technical communication No. 2, 1956.)

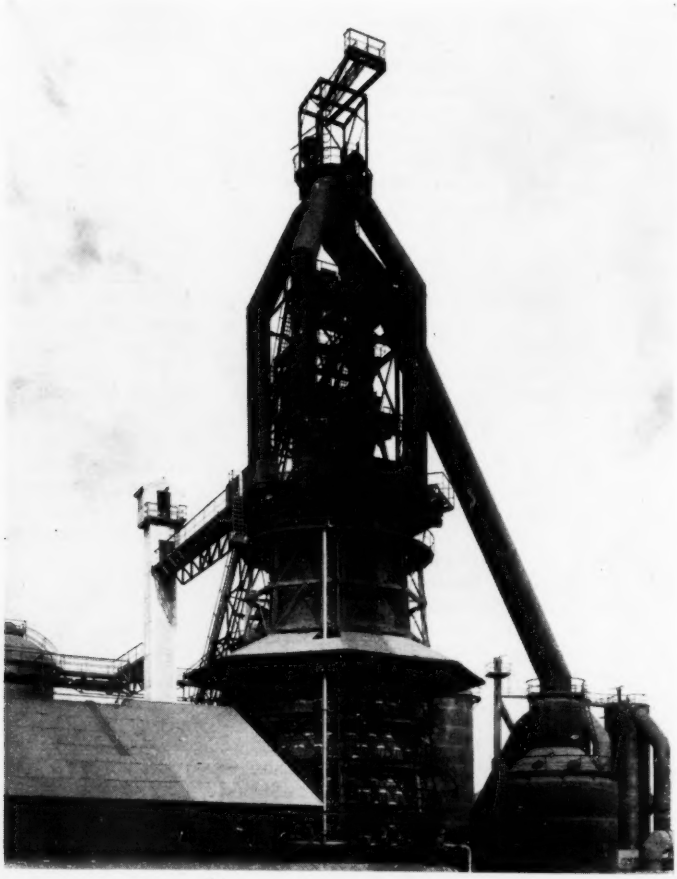
WOOD, G. A. " The Determination of Tin in Soils." XX Congresso Geologico Internacional, 1956.

New Blast-Furnace at Millom

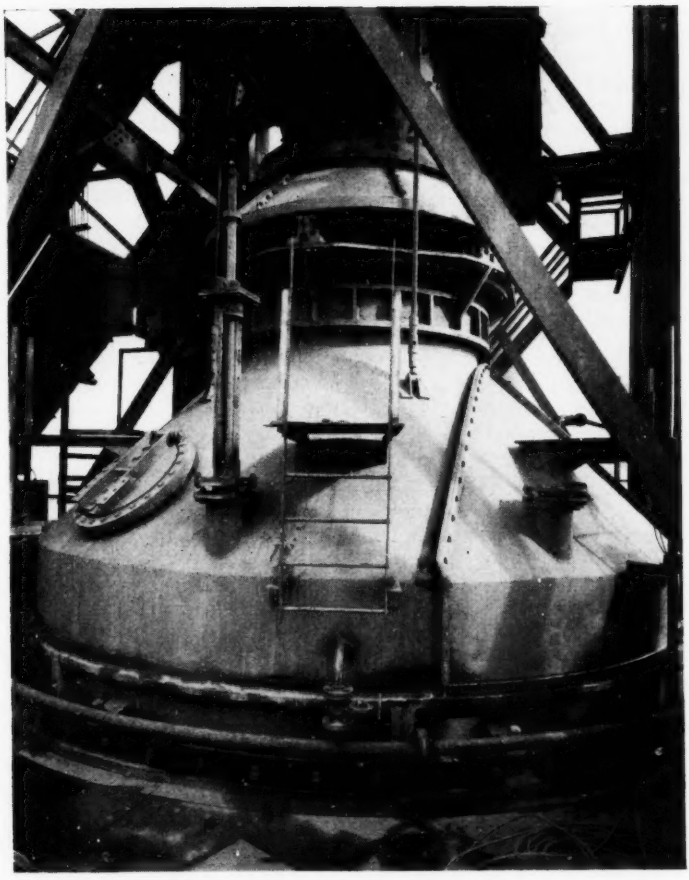
Fired early in May the new furnace incorporates certain unusual features

Introduction

The Millom Hematite Ore and Iron Co., Ltd., largest producers in Britain of high-grade hematite pig-iron and other special quality pig-irons, recently put into operation at their works at Millom, Cumberland, a new blast-furnace which incorporates certain unusual features of special interest to the iron and steel industry. First fired on May 3, the new furnace is mechanically charged under full automatic control, an operation which can be controlled by one man, against the nine or ten required with older hand-charged furnaces. With appropriate burden, the furnace (No. 1) has a production capacity of up to 800 tons of hematite pig-iron per 24



General View of the New No. 1 Blast-Furnace.



Marley Roll-Back Revolving Distributor.

hours, or about 5,500 tons a week. This, together with another blast-furnace (3,500 tons weekly capacity), gives the works a possible output of 9,000 tons a week. (A third furnace, which had produced more than 1,000,000 tons of hematite pig-iron since it was blown in on April 11, 1953, has been closed down for relining).

Furnace Design

The special features of the new unit are :—

(1) The stack columns are arranged so that the whole of the top weight of the distribution and charging gear, together with the furnace top platform, are carried direct on to the main support columns instead of on to the stack casing. Since the cooler platforms are also carried on this structure the arrangement involves very little extra steelwork than conventional cooler platform designs. Also the stack plates are not as thick as they otherwise would have to be.

The important aspect of this novel arrangement is that the whole stack is free to expand and, in the event of any fracture of the casing, the top weight, which is considerable in modern blast-furnaces such as this, causes no danger. Individual plates, or if necessary the whole stack, may be replaced safely without interference to the top gear.

(2) The mechnical charger is of the contractors standard double-bell revolving-distributor type, but embodies a special feature which permits the splitting of the gas seal and rolling back the distributor and receiving hopper to facilitate quick changing of the large bell.

The stockline sounding rods are constantly in the furnace, except during main bell operation, and their movements are electrically transmitted to dial indicators and recorders, which give a constant indication and record of the stockline movements and of the time when each charge is dropped.

The design, supply, and erection of No. 1 furnace and ancillary plant was carried out by Wilfred Marley, Ltd., of Workington. In addition to the furnace proper the installation includes a double-skip hoist complete with charging apparatus, coke weighing and screening equipment, scale-car and bunkers, and connecting mains and valves.

The new furnace was planned and designed with the aim of supplying a unit which would give quality and quantity of product, reduction of manual effort, uniformity of operation, reduced maintenance, and conservation of materials. The dimensions of the furnace itself are :—

Well, 20 ft. diameter by 11 ft. 4½ in. deep ; bosh, 20 ft. diameter at the bottom, increasing to 24 ft. diameter at an angle of 79° 42′ through a height of 11 ft. ; stack, 24 ft. diameter at the bottom, parallel for 7 ft. 6 in. and then tapering to 18 ft. 6 in. diameter through a further height of 38 ft. 6 in., and throat, 18 ft. 6 in. diameter and parallel through a height of 8 ft. 6 in. The total height from the tap notch to furnace top platform level is 84 ft.

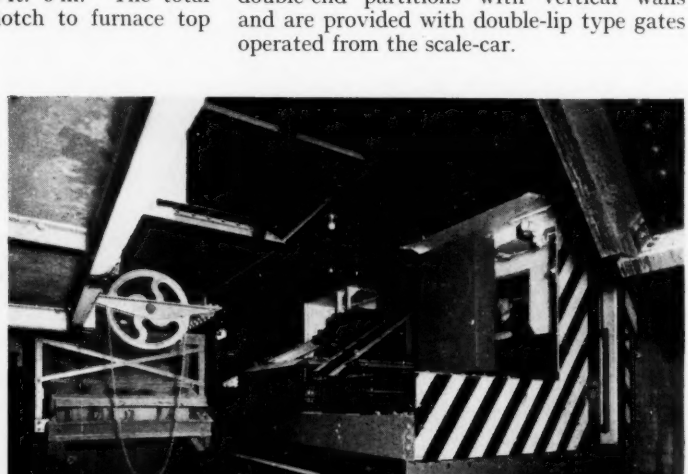
The furnace has 16 tuyères fed from a bustle main 3 ft. diameter inside brick lining.

The cooling arrangements provided are :—(1) For the hearth jacket and bosh—by sprays ; (2) for the tuyère belt—by three rows of inset flat copper coolers, and (3) for the stack—by 14 rows of inset flat copper coolers over a large portion of its height. Four gas offtakes have been provided, together with uptakes leading into a single gas box from which a single downcomer is led to a primary dustcatcher. The dustcatcher connects to existing gas mains and a suitable isolating valve has been installed. Dust discharge is either direct or through a single-shaft pug mill.

Ancillary Equipment

Some details of the ancillary equipment, apart from the mechanical charging equipment described above, are :—

Bunkers.—The bunker range is 175 ft. long, comprising 11 bunkers in all, including two coke bunkers of 21,000 cu. ft. total capacity and nine bunkers for other materials of 28,000 cu. ft. total capacity. These capacities allow for not less than 12 hours' supply of burden materials. The materials are delivered to the bunkers in drop-bottom wagons. Each coke bunker has one centrally-placed discharge point. All other bunkers have double-end partitions with vertical walls and are provided with double-lip type gates operated from the scale-car.



Scale Car of No. 1 Blast-Furnace.

The coke bunkers, which have a "gunnite" lining, are placed centrally over the skip pit and from each a conveyor feeds coke over a static screen to a weigh hopper. The feed to these hoppers to required quantity is under automatic control and the weight is automatically shown by an indicator and a tape recorder. Discharge to skip is by air-operated gates controlled by the scale-car operator.

The screening rejects are discharged through a disposal chute into a small skip hoist, which delivers into a rejects hopper. This apparatus is also automatically controlled.

All other materials from the bunkers are dealt with through the scale-car.

Scale Car.—The scale car is of the contractors standard type, with a single 110 cu. ft. capacity weigh hopper, and incorporates a four-wheel spring-mounted chassis. It is electrically operated by a totally-enclosed traction unit and runs on standard-gauge track, closely supported on steel sleepers laid in concrete. Compensated pressure air brakes are fitted. Detail and gross weighings for each charge are shown by a dial indicator and a tape recorder.

The weigh hopper has bottom discharge by air-operated gate of double-leaf and large area type to ensure complete emptying after each filling.

The bunker gates are also air-operated from the car by means of robust gate lifters and the indicator and controls are positioned to give good sighting and ease of control for all operations, allowing efficient operation with a good time margin for the operator.

Hoist and Charger.—The inclined hoist to the furnace is of the double-skip type. The twin skips, each of 160 cu. ft. capacity, have wheels mounted on taper roller bearings and are hoisted by a 125-h.p. winch situated in the hoist house. Also situated in the spacious hoist house are pneumatic bell operating cylinders, sounding-rod winches, motor-generator set, and the main electrical control apparatus. Hoisting time is 45 sec. from start to stop and maximum skip rate is 40 per hour.

The furnace bells are compressed-air operated. The main-bell hopper capacity is 810 cu. ft. and that of the distributor hopper 160 cu. ft. The main bell is 12 ft. 11½ in. diameter, has an angle of 53°, and opens 2 ft. 6. in.; the auxiliary bell is 6 ft. 6 in. diameter, has an angle of 50° and opens 2 ft. 6 in.

All primary controls are placed in a station positioned at the bottom of the hoistbridge and convenient for the scale-car operator, who starts each skip by push-button control, following which all movements of hoisting and charging follow automatically in set pre-selected sequence, or in part independently as desired. Operations are fully safety interlocked to prevent movements out of sequence. This interlocking also allows for "jigging" of the bells to clear obstructions in the event of these failing to close and seat properly.

The rate of operation of the scale-car and the hoist and charging apparatus allows for the input to the furnace for normal production to be obtained when the apparatus is working at 55% to 60% of its maximum rate, so as to allow ample time reserve.

Ore-Dressing Notes

Developments in Electronics

(1) *Sorting.*

For a number of years the LaPointe picker has been used to detect and sort radioactive material by means of the Geiger-Muller tube. The principle has now been extended to reef-picking and removal of waste from radioactive Rand bankets. The method was discussed in the *South African Mining and Engineering Journal* for February 24, 1961, following on the successful demonstration at Benoni referred to by our Johannesburg correspondent in the April issue. Run-of-mine ore is screened and washed, fine material going to the mill and coarse ore sized if necessary and fed to one or more sorting units. From a surge hopper it is fed on to a spinning plate which throws each piece against a side skirting plate and thus drops a single-line stream of ore on to a short delivering conveyor. From the delivery end of the conveyor each particle falls freely past three successive devices. First, the rock falls between a neon light working on high-frequency alternating current and a photo-electric cell tuned only to this frequency; the transit time required by the rock is the measure of its size. As its fall continues it next passes in front of a scintillometer, which determines whether its radioactivity is above or below a pre-set level. This level, based on the fact that the gold-to-uranium ratio on most Rand mines is fairly

constant, makes it possible to classify each piece as "pay" or "un-pay". Falling further, the rock passes in front of a series of air jets which are controlled electronically by the transit timer and scintillometer. If the lump is payable the jets do not operate and it falls to the mill conveyor. If it is below milling grade the air blast operates and the rock is blown sideways, finishing on the waste conveyor. The same rejection is made with any other non-radioactive material such as steel or mine timber.

In a demonstration one unit was fed with rock sized between 2 in. and 8 in. at speeds varying from 25 tons to 50 tons hourly. One shiftsman can supervise six units, each of which occupies a floor space of 8 ft. by 12 ft. and standing height of 20 ft. to 30 ft. and takes 4 h.p. *plus* 50 cu. ft. of compressed air per minute. Sorting over the three devices involves a drop of 2½ ft. and takes 0·1 sec. The scintillometer has a shield of lead weighing six tons to avoid background interference. The blast valve can work up to a rate of 130 times a second.

The article abstracted here goes on to speculate as to possible applications of the method to direct use underground instead of only ahead of milling. It suggested that with sorting near the face longwall and longhole stoping could be developed without the present difficulty where part of the ore is un-pay. Perhaps the present stage of washing and fines removal will prove insuperable obstacles to what might well transform the economics of mining and hoisting, together with that of packing back waste as roof support. As with all new methods, judgment should be withheld until operating data from more extensive field use become available.

Trends in Practice

(2) *General.*

Writing in the Rhodesian *Chamber of Mines Journal* for February, 1961, J. P. B. Stuart surveys the directions in which mineral processing is to-day tending. In ore storage it is now normal to hold a day's supply of crushed ore ahead of the grinding section, with up to another day's supply awaiting crushing. The question is one of economics and ground storage in a stock-pile is increasingly favoured. A plough feed, developed in Johannesburg, is now available in this connexion. It has a simple mouldboard arrangement and is either self-motored or driven by a winch. It extracts ore from the stock-pile in both directions of travel at a controlled rate. The article does not say whether this arrangement would work on frozen material such as must be handled in less climatically favoured latitudes than those of Africa.

Turning to the actual work of crushing and grinding, the author finds that three-stage crushing from run-of-mine size to *minus* ½ in. or less, with the final stage in closed circuit, is going out of favour save for relatively dry and soft ores. Many plants now run this last stage in open circuit or finish with rod-milling ahead of the usual ball- or pebble-milling. Ground in South Africa is being gained by three-stage crushing to *minus* ½ in. or finer, followed by pebble milling in closed circuit. Wet or dry autogenous grinding direct from the *minus* 12 in. range is being installed in some new mills.

The term "autogenous" in this connexion refers to a run-of-mine feed as distinct from the use of pebbles or selected screened fractions of ore. Choice of layout is influenced by breaking characteristics of the ore, the percentage of large material as mined, wetness liable to lead to operating trouble if the ore is not previously washed, and unit cost of power. On the Rand, with this at 0·5d. per kWh, the extra power needed for pebble-milling is more than balanced by reduced consumption of balls and, as flotation there is a minor post-grinding treatment, the need for close control of size range in the pulp sent for treatment is not of high importance to the mill management. Pebble-milling is favoured by the availability in most Rand ores of screened 1½-in. to 3-in. material and by the fact that pulp is better oxygenated in the absence of abraded steel.

In classification the mechanical classifier continues to hold its ground outside Africa, notably in the first part of two-stage grinding. One trend is toward the reduction of pumping in the grinding circuits, open-circulated rod-mills being followed by classifiers which can move their return sands back to the ball-mill. Where cyclones close the secondary circuit, pumps are, of course, standard necessities. One new development of the Dutch State Mines is the "siphontrol" system, developed in order to maintain relatively steady underflow conditions from a varying feed. Both the cyclone overflow and underflow pipes are submerged in separate sealing vessels in such a way as to form a closed barometric leg. The weight of slurry in the underflow leg must be

sufficient to over-balance the lifting force due to siphon action in the overflow leg, the extra power needed to initiate and sustain overflow being provided by the kinetic energy in the cyclone system. When the underflow percentage of solids falls below the required level the column of overflow slurry is then unable to discharge through the siphon.

Dry Blending of Talc

(3) *Handling.*

The tremolitic talc ores of the Gouverneur district, N.Y., provide one of the world's main sources of supply.[1] Most of the output is sold to stringent industrial specifications, the ceramics and paint industries being the main consumers. The problem of blending Gouverneur Talc Co.'s five grades of ore has led to interesting developments in the binning and blending of this finely-ground material. Dry grinding is either performed in pebble-mills with air separators or in a fluid energy circuit. The latter delivers a 5 μ product for the paint industry. After grinding the finished grades are pumped, dry, to bulk storage silos whence they are reclaimed as necessary and bagged or delivered to hopper cars.

In the method now superseded segregation and erratic blending led to lack of uniformity of the sales product. The material was then pumped through 4-in. or 5-in. pipelines to the top of its silo and discharged centrally. This led to segregation during fall, a trouble accentuated by discharge through a single conical bottom port. The first improvement was to pump the material up from the bottom, giving a fluidized bed of talc which mixes continuously with the mineral already there. It is not mobile in the way that a FluoSolids bed would be, as the entering material makes its own channel. This follows the line of least resistance, thus stirring the contents. Not only has this improved mixing, but it also facilitates withdrawal. Two large new silos, called for by expanding production, have each four 60° sloped conical hoppers in their 40-ft. diameter cross-sectional area. Each discharges into a fluidizing conveyor. The conveyors converge to a common delivery pump. Feed to the new silos is to the sides of two of the cones, near their tops. In his description of the plant the author, R. S. McLellan, observes that in the 15 months since completion operation has fully met expectations.

[1] *Min. Engg.*, Mar., 1961.

Two-Minute Copper Assay

(4) *Control.*

Anaconda has now succeeded in reducing to a routine plant operation the scanning by fluorescent rays of its bulk tailing, scavenger tails, and concentrates. The assays are almost instantaneous and are recorded as a continuous tracing. There is a time lapse of two minutes between taking a sample and reading the result.

The stream of pulp is bled through a sample holder and in passing is bombarded by primary X-rays. These excite the elemental atoms present, which then emit a secondary radiation characteristic for the elements concerned. A selected portion of this secondary radiation is made to fall slantwise on a lithium fluoride crystal, which disperses the beam and directs the fraction characteristic of the element under scrutiny (in this case copper) on to a Geiger-Muller detector which measures its energy and operates a scaler and printing-out mechanism. Assay of a prepared sample with the Quantrol apparatus was fairly straightforward, but the problem before the mill engineers was that of sending a representative sample rapidly to the sample holder. It was necessary to break with traditional systems based on hand cutting, to take advantage of the natural flow turbulence (a guarantee of effective mixing), and to apply the X-rays to the passing pulp. Laboratory experiments showed that for high quality of assay any variations in pulp density must be allowed for, since only the surface is scanned and the percentage of copper particles exposed at this surface varies with the solid/liquid ratio. Accordingly a density gauge sensitive to the percentage of solids was built into the system.

Tests in the plant began in late 1959 and showed that more work must be done on the method of collecting and transporting small streams of pulp, with such special problems of wood fibre, air bubbles associated with flotation reagents, and materials of piping construction. As now operated a sampling device cuts the pulp at the collection point and sends it to a vibrating screen, where wood fibre is removed. The pulp then flows at low head through small-diameter rubber tubing to the holder in the sample cell scanned by the X-ray spectrometer. With the information now available higher concentrate grades and improved recoveries are reported, and assaying costs are lower.[1]

[1] *World Mining*, March, 1961.

South Kalgurli

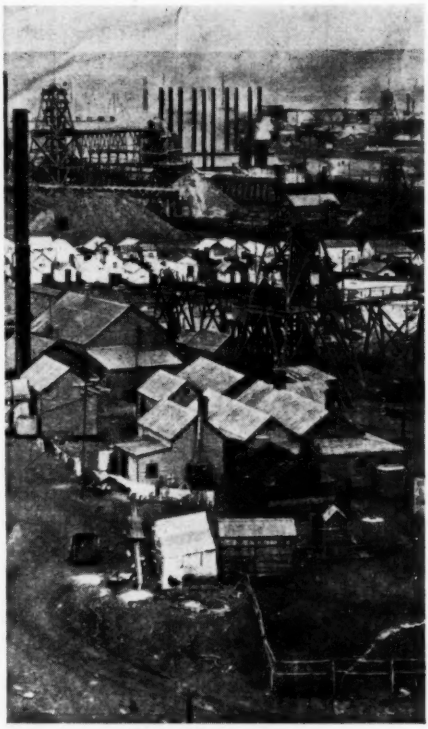
South Kalgurli, a one-time glamour operation on Western Australia's "Golden Mile," was for long an important gold producer.

In its very earliest years of 1894–95 it consisted of two very small areas, of total 13 acres—the Gallic and the Gallic Extended.

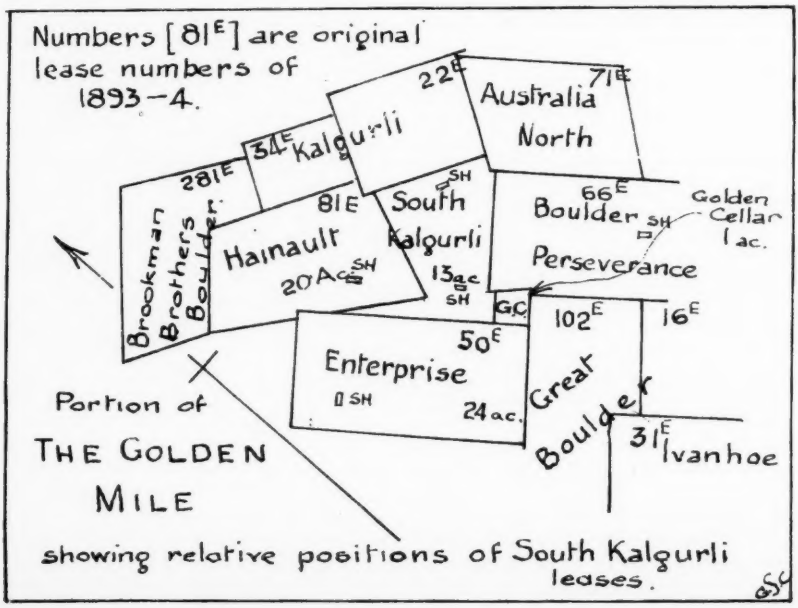
The real value of the ground (which is totally surrounded by high-grade areas) was not recognized and at one stage one portion of it was even "forfeited for non-payment of rent."

John Morty was the first to combine the two areas and the South Kalgurli mine resulted; this, from 1895 to March, 1913, treated about 750,000 tons of ore for 287,000 fine oz. of gold. The neighbouring lease on the northern end, the Hainault pegged by Sutton in November, 1893, was of 23 acres and also formed into a company. To March, 1913, it treated 470,000 tons of ore for 173,000 oz. of gold. Then came the merger, the combination being named the South Kalgurli Consolidated. Also came the glamour period, with about 60 dividends (25%, 30%, and even 50% for years) amounting to a total of much more than £1,000,000. The main shaft was sunk to 2,334 ft. but, unfortunately, was originally planned with very small sectional area.

In 1955 the Consolidated became part of that active organization of Gold Mines of

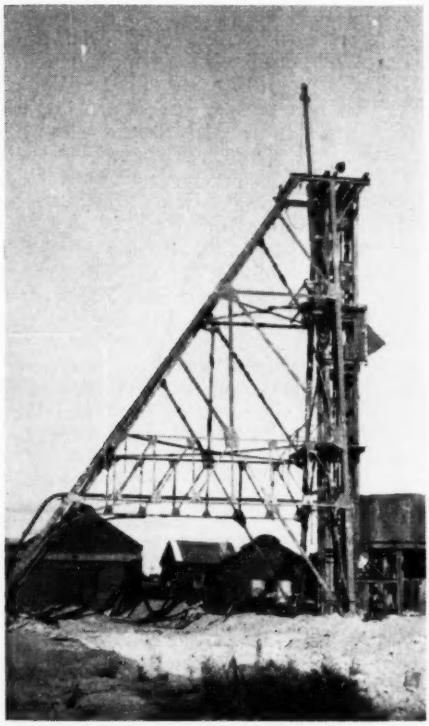


Main Shaft, 1903.



Kalgoorlie (Aust.), Ltd., which then allowed of more modern and convenient methods of working the underground areas from the shafts of the Perseverance (depth 2,300 ft.) or the Victoria shaft of the Kalgoorlie Enterprise (2,800 ft.) In May, 1959, the last skip of ore was hoisted at the old main shaft and since then ore has been withdrawn through the transport levels and ore-pass systems to the other shafts.

Production of ore from the (old) South Kalgurli leases thus continues. During the last two years many of the old buildings and surface equipment surrounding the old shaft have been cleared away and in May, 1961, a commencement was made to dismantle and remove the steel headframe, thereby removing what had been a very important component in South Kalgurli operations but also somewhat of a landmark in that particular area; the landmark of an area that employed thousands of good men over a long span of years.



Steel Headframe, 1939 : Now Being Dismantled.

Of the steel headframe a few remarks may be in order. The original one, of timber, lasted until 1939, being raised, braced, or stiffened occasionally when necessary. During 1939 the design for a steel frame was prepared on the mine and the steelwork fabricated at the old Kalgoorlie Foundry. The erection took place without interference with the mining or hoisting operations over the top of or round the timber structure. The actual change-over was effected at a week-end, with no loss of mining time, quite a feat of engineering organization. (The two days were extremely cold with a blustery drizzle; so a bottle of good whisky consumed at the completion of the job was considered a very proper charge and well-earned.)

Before 1913 production from the South Kalgurli and Hainault (as separate units) was 1,194,740 tons of ore for 460,295 fine oz. of gold. Consolidated to April 19, 1955, produced 3,167,556 tons of ore for 1,150,372 oz., a total of 4,352,296 tons for 1,610,667 oz.

An early photo of the old South Kalgurli shows that the lease area was heavily cluttered with buildings and equipment, the removal of which now permits of further work at or near the surface. In those very early years, and long before very accurate knowledge was available of the areas, buildings, shops, stores, residences, and even " camps " took up almost every square inch of ground area, so that mining work was greatly restricted. To-day another era has opened.

G.S.C.

Engineering Log

The newly-discovered deposits of natural gas in the Dutch province of Gronningen should be of considerable economic importance. Not only is the gas exceptionally pure but its proximity to the Ruhr should facitate the marketing of any excess to Holland's own consumption—if, indeed, the gas field does not actually extend into Germany. One rough guess is that there are 300,000,000,000 cu. metres—twice that of the estimated Lacq field in France. The true quantity seems to lie between this and the conservative official figure of 50,000,000 cu. metres. Holland's present coal consumption is some 12,000,000 tons per annum, a shortfall on production of 4,000,000 tons. In addition 6,000,000 tons of liquid fuel are at present imported. The economic problems

raised by this new competitor with Lacq and with the Hassi R'Mel deposits in the Sahara are intricate and the big new refining and storage installation near Rotterdam also comes into the picture.

* * *

Canada uses some 5,000 tons of flaked mica annually, which at present comes mainly from the U.S.A. A deposit now being mined in the Yellowhead Pass through the Rockies should in due course take over as the source of supply. Regular shipments are now made from a strip-mined surface working.

* * *

Some of the British Area Coal Boards are now granting exemption from continuous manning of the fan house responsible for underground ventilation, provided approved instruments are used to monitor the fan pressure and operate warning devices in the event of trouble. The basic equipment in the fan house must then include a direct-reading manometer for showing local pressure; a pressure transducer which indicates the fan pressure effect at a distant point ; high- and low-pressure alarms ; bearing temperature measurement operating alarms, and a time-delay switch which cuts the motor at a pre-set interval after the alarm signal. These devices can be reinforced by other automatic controls such as those which would indicate belt slip, fan-belt breakage, or change of fan speed.

* * *

Information on gear lubrication obtained from experimental work by David Brown Industries is given in a paper by G. C. Mudd in the *Institute of Petroleum Review* for April, 1961. Most metals are coated with a film (usually invisible) of oxide, without which their coefficient of friction would be increased up to twentyfold. If sliding contact occurs this film is removed and, with the consequent metal-to-metal contact, damage due to welding results. With gear teeth, where there is much sliding, the lubricant used must keep the metals apart. Sliding is accompanied by frictional heat and a secondary function of the oil supply is to move this away. With high loading of the gears or severe sliding the film fails and damage ensues. The oils used in gears require several special properties. At the temperatures generated the formation of sludge and the tendency to oxidize are increased. If in addition there is contact with water formation of emulsion must be provided against. In conditions of extreme pressure the oil must bond chemically to the metal surface and additives for this purpose usually have a phosphorous or sulphur base. Up to a peripheral gear speed of 2,500 ft. per min. oil can be applied by letting the teeth dip into a containing vessel, provided this is enough to dissipate the heat. Up to 4,500 ft. per min. the gears may be lubricated by an oil bath enclosed in a shroud but it is better to spray the oil on to the gear teeth and so avoid channeling. Extreme pressure oils should be used in hypoid gears such as those in the rear axle of a car, and the gears themselves should be phosphated, thus aiding the lubricant in its bonding and also giving some porosity to the metal surface. Severe conditions also occur in worm gears, which can be dip-lubricated up to a pitchline peripheral speed of 2,500 ft. per min. Above this speed they should be given jet lubrications.

* * *

A mine which uses roller cone bits to drill 9 in. holes to a depth of some 53 ft. has found that a detergent in the drill water shows definite advantages. Dust control is improved, there is a faster drilling rate, and the life of the bit bearing is increased. The rocks penetrated include monzonitic and dacitic porphyry, alaskite, and a hard, very abrasive, silicified sedimentary. The detergent was first used to reduce the consumption of dust-allaying drill water and resulted in a 50% cut, together with virtual elimination of the dust problem. The emollient effect of the detergent on the bearings on which roller cones rotate allows more than a 25% increase in drilling thrust and a step-up of penetration rate of 10%. The chemical used is a proprietary dodecal benzine sulphonate and from 1 lb. to 11 lb. are added to 100 gal. of water. There is no visible effect on the mill flotation which follows extraction of the ore.[1]

* * *

A new method of extracting drinking water from the sea has been developed and is soon expected to be in commercial use. It uses a tube containing revolving blades which resemble those of a car's windscreen wiper. Seawater is fed into the tube and spread into a thin film over the walls, which are steam-heated. The water vaporises and is removed at the top of the tube while concentrated brine is discharged at the bottom. Some 42 lb. of fresh water are recovered from each

[1] *Min. World*, Dec., 1960.

100 lb. of seawater with the expenditure of only a quarter of the energy needed by other distillation methods. The device is economical of space and, since the distillation proceeds well below boiling point, there is no " priming " and only one part per million of salt in the distillate.

News Letters

BRITISH COLUMBIA

June 9.

Kamloops.—The Japanese Government has approved the export of funds by the Sumitomo group of companies to bring the Highland Valley property of the Bethlehem Copper Corporation, Ltd., into production in 1962. Sumitomo is supplying $500,000 through the purchase of 400,000 Bethlehem capital shares at a price of $1·25 per share and is to make a loan of $5,000,000 upon the security of a first-mortgage debenture bearing 6% interest. Sumitomo is also to purchase all Bethlehem's production for a period of 10 years at prices quoted periodically by *E. and M. J.*, New York, Export Refinery, 90% payable when concentrate is loaded at Vancouver and the remaining 10% when it reaches the Japanese smelters. Loan repayment is extended over a six-year period. Further financing will be done by a contractor who has agreed to expend $1,500,000 for mining equipment and by Bethlehem itself through a $1,000,000 loan from a Vancouver bank. Mr. H. H. Huestis, president of the Bethlehem company, has stated : " The gross value of the Sumitomo contract using an average selling price of 30 cents per lb. of copper is estimated to be $74,000,000 and the company is expected to realize an operating profit of approximately $25,000,000 over the ten-year period."

Skeena.—The Granby Mining Co., Ltd., made a further payment late in April of $225,000 to exercise its option to purchase the Harriet Harbour iron properties from Silver Standard Mines, Ltd. The remainder of the purchase price is to be paid out of earnings. Recent diamond drilling has increased ore reserves which are now estimated at 4,700,000 tons, sufficient to produce 2,570,000 tons of iron concentrate. With these additional reserves the sales contract with Sumitomo Shoji Kaisha, Ltd., was re-negotiated and the amount of the contract doubled to 2,000,000 long tons of iron concentrate to be delivered over a five-year period. The value of the proposed shipments is estimated at $19,000,000. Plans have been prepared for the development of the property and construction of a 2,200-ton mill.

Victoria.—Cowichan Copper is studying the merits of placing its 1,500-ton mill near the river ore zone, 7,000 ft. underground from the portal of the main adit. It has been decided to place the crushing and grinding units near the productive sections and the management is considering the addition of the flotation units, leaving only the filtering and thickening units for surface installation. The company is required to be in production by November 1 of this year through its contract with Sunro Mines, Ltd., a subsidiary of the Consolidated Mining and Smelting Co. of Canada. The sales contract with Mitsui and Co., Ltd., calls for delivery of 110,000 tons of 25% copper concentrate. Ore reserves are estimated at 2,000,000 tons, of which 1,700,000 tons will be required to meet the minimum target.

National Explorations, Ltd., has underwritten new financing for the development of the Privateer mine, owned by New Privateer Mine, Ltd., and an adjoining copper prospect. The Privateer shaft is being unwatered and diamond drilling will be performed from the floor of the 13 level to test depth persistence of three known veins. The availability of E. G. M. A. is a prime factor in the new effort to produce gold. Close trenching of the adjoining copper prospect has revealed 2·22% copper over a width of 17 ft. and length of 400 ft.

Vancouver.—A three-year labour agreement has been accepted by the Britannia Division of Howe Sound Company and Local No. 663 of the International Union of Mine, Mill, and Smelter Workers, providing for a 10 cents increase hourly in wages on three stages commencing with 4½ cents in the first year and additions of 3 cents in each of the following years. Of the first year's 4½ cents 2½ cents is to be retained in a savings plan to be matched equally by each hourly-rated employee. The pension plan, previously suspended, has been terminated.

New Westminster.—Giant Nickel Mines, Ltd., made its twelfth shipment of bulk nickel-copper concentrate to Japan on May 26, 1961. It contained 3,039 wet tons assaying 11·01 % nickel and 4·10% copper and carried an invoice value of $328,089.

Ore reserves of the Canam Copper Company, whose mine is situated 25 miles east of Hope, are now estimated at 2,000,000 tons grading 0·04 oz. in gold and 0·88 oz. of silver per ton with 1·44% copper. A great deal of the ore zone remains to be opened on the new bottom level

and consequently the company is confident of adding to the reserves.

Golden.—Low-level development has indicated a sharp improvement in the grade of ore in the Mineral King mine of Sheep Creek Mines, Ltd. At the last report the 7 level drive had advanced 30 ft. with a full face of 11% in combined lead and zinc. Persistence of the same ore-shoot to a greater depth of 200 ft. vertically has been confirmed by a drill intersection of 12 ft. containing 4% lead and 10% zinc.

The authorized capital of the Columbia Gypsum Company has been reduced to $3,294,525 through the purchase by the company of 1,706,475 shares directly from shareholders. Of the authorized capital only 1,453,365 shares are outstanding. In the past year the company sold its gypsum properties in the East Kootenay area to Western Gypsum Products, Ltd., and then supplied the principal funds for the incorporation and first year's operation of Klondike Lode Gold Mines, Ltd.

Nicola.—Substantial wage increases were granted by Craigmont Mines, Ltd., to its employees as a result of direct negotiation with Highland Valley and District Local No. 1011, International Union of Mine, Mill, and Smelter Workers. The agreement will continue for four years, during which it is expected to provide stability with a wage scale that ranks with the best in the mining industry. Both parties are making vigorous representations to federal authorities for action with regard to housing.

On the advice of Mr. R. Allen, the consulting geologist, Merritt Mining Explorations, Ltd., is to proceed with geological mapping, soil sampling, stripping, and assaying at an estimated cost of $10,000 on the P. C. group of 50 claims and fractions, 6 miles north of the Craigmont mine.

A camp has been established by Mid-West Copper and Uranium Mines, Ltd., on its Promontory Mountain group of claims, one mile south-east of the Craigmont mine. Mr. F. J. Hemsworth, the consulting engineer, has constructed an analytical laboratory for testing soil samples for copper content by the rubeanic acid method. Mid-West has leased its Velvet copper-gold mine near Rossland and is now receiving royalties in the range of $20,000 annually.

Quatsino Copper-Gold Mines has purchased the 18-claim "BB" group, 10 miles north-west of the Craigmont mine. Plans for exploration are contingent upon a report being compiled by H. Hill and L. Starck and associates, consulting engineers.

Vanex Minerals, Ltd., has purchased 23 mineral claims and subsequently staked 52 additional claims in a block on the east side of the Thompson River, near Spatsum, on the main line of the Canadian Pacific Railway between Spence's Bridge and Ashcroft. A camp has been established and geological mapping and trenching are now in progress. Underground workings, many years of age, will be rehabilitated and examined. The principal copper indications are only 300 ft. above the railway tracks.

Greenwood.—In the seven months to February 28, 1961, McKinney Gold Mines shipped 4,482 tons of siliceous ore grading 1·20 oz. gold per ton to the Trail smelter. After deduction of freight and handling charges the shipments netted $180,689 equivalent to $40·20 per ton.

EASTERN CANADA

June 20.

Ontario Gold Output.—The output of the 30 producing gold mines of Ontario for April included 225,836 oz. of gold and 32,949 oz. of silver, valued together at $7,842,394, from 770,931 tons of ore milled. The average number of workers employed was 10,777 and the average grade of ore treated was $10·17.

North-Western Ontario.—In 1960 Madsen Red Lake Gold Mines treated 306,377 tons of ore for a bullion output valued at $4,088,904, the profit for the year being $685,744. At December 31 last the ore reserves were estimated to be 650,930 tons averaging 0·330 oz. of gold per ton.

Campbell Red Lake Mines reports a profit of $1,713,620 in 1960, in which year 257,898 tons of ore was treated and bullion worth $5,597,049 recovered. At the end of the year the ore reserves were estimated to be 1,128,100 tons averaging 0·654 oz. of gold per ton.

Atikokan.—From an inclined prospect shaft being put down on its Lake St. Joseph prospect Steep Rock Iron Mines plans to put in a 1,000-ft. cross-cut across the deposit in order to get a bulk sample of some 3,000 tons. Tests on the ore are then to be made to work out a flow-sheet.

Manitoba.—A net profit of $10,351,583 for 1960 has been reported by the Hudson Bay Mining and Smelting Company and its subsidiary, the income from metal sales in the year being $45,696,520. At December 31 last ore reserves totalled 15,834,900 tons, with average grade of 0·59 oz. of gold and 1·00 oz. of silver per ton, and 2·63% copper, 5·2% zinc, and 0·4% lead. Since the start of operations, it is pointed out, over 50·5 million tons of this production was from the Flin Flon orebody. In recent years increasing production from the smaller satellite mines has resulted in greatly extending the life of the original mine.

North-West Territories.—The Watson Lake tungsten orebody opened up by the Canadian Tungsten Mining Corporation is likely soon to be brought to the production stage. The necessary finance is to be provided, it is stated, by Northwest Amax (the Canadian subsidiary of American Climax), Ventures, Ltd., and Dome Mines. A new road is planned from the Alaska Highway to the mine, where the main orebody is now estimated to carry 1,176,400 tons of ore averaging 2·47% tungstic oxide.

Quebec.—In the first three months of the current year the Quemont Mining Corporation milled 213,701 tons of ore, or 2,374 tons per day, averaging 0·155 oz. of gold, 0·81 oz. of silver, 1·33% copper, and 2·47% zinc. The estimated operating profit after provision for taxes was $495,900 and, after writing off $78,900 for depreciation, the estimated net profit was $417,000, equivalent to 20 cents per share.

In 1960 Lake Asbestos of Quebec, Ltd., treated 1,650,510 tons of rock and recovered 86,621 tons of fibre. Production at the Black Lake mine is expanding, the 1959 output being 56,890 tons.

A drilling party has been sent to its asbestos property in Ungava by the Murry Mining Corporation. Four sampling holes 25 ft. are planned. Work to date has, it is stated, outlined 11,681,260 tons of ore averaging $18·50 a ton.

The mill of the Normetal Mining Corporation treated 91,472 tons of ore in the March quarter, the estimated profit for the period being $275,000. Shareholders have been informed that development on the lower levels since the end of 1960 has been mainly directed to preparations for ore-pass raising and deepening No. 4 shaft. Before suspending ore development on the 5560 level about 70% of the ore zone had been tested by diamond drilling and indicated 426 tons per vertical foot averaging 4·62% copper and 1·78% zinc; this work is to be completed together with the development of the 5760 and 5960 levels after shaft sinking has been finished. Sinking at No. 4 shaft commenced on March 31.

Rio Tinto Mining Co. of Canada.—The Rio Tinto Mining Company of Canada has announced that the balance of its 5% debentures has been called for redemption on August 1, the redemption price being $101. Of the original $15,000,000 of 5% debentures issued in 1956 the balance outstanding for redemption is $8,350,000.

AUSTRALIA

June 20.

Gold Mining.—The position of the gold-mining industry is becoming increasingly difficult because of the steady increase in wages, not only in the industry itself but in all industries which contribute to mining operations. Mining has fought a hard fight against costs but four quarterly adjustments in 1960 have raised the basic wage on the Western Australian goldfields by 13s. 2d. per week as compared with an increase of 7s. 4d. per week in the corresponding period of 1959; marginal increases have also been granted in the period. The general incidence of the Gold Mining Industry Assistance Act is too narrow to maintain vigorous enterprise. Under the present conditions of rising costs there is a state of gradual contraction and a fear of probable extinction. In Australian conditions the threat is not to actual mining employment alone, but to communities which form almost the entire population of large outback areas and the support of inland townships. Financial assistance is becoming more and more necessary not only for protection but also to stimulate the opening up of new orebodies and new mines. Exploration and development are the basis of preservation of the industry.

Exploration.—The possibilities of mineral export trade, particularly with Japan, are being actively examined by various interests. The Union Carbide Company of New York has been granted six mineral reserves in Western Australia, which could lead to the investment of substantial sums in exploration. Temporary mineral reservations cover vanadium-bearing rocks in the northern parts of the State, near Roebourne and Meekatharra, and also in country nearer Perth.

It is reported that a large iron-ore deposit has been located near the Broken Hill railway line. A number of iron-ore deposits exist in the locality. Ferrous content is provisionally estimated at 36% to 60%.

The South Australian Government is reported to be examining an occurrence of reported magnetic material in the Eyre Peninsula, over which aeromagnetic surveys have been flown. The indication is considered to be of sufficient importance to warrant examination by ground parties and an expenditure of £20,000 for drilling has been approved.

Queensland has strong hopes for the satisfactory development of the Constance Range iron-ore deposit by Broken Hill Proprietary. Development work has been in progress over two years, but it is understood that a considerable programme still lies ahead. On present information the deposit is suitable in part for open-cut and partly for underground mining. The State has hopes that ultimately ore deposits may be located of sufficient importance

to justify the establishment of a State steel industry. Bearing on this viewpoint attention has been attracted to a new ore discovery near the Kianga-Moura coalfield. These occurrences were unknown until recently and will now be extensively prospected in the hope that they may be of such size and grade as to lead to the foundation of a State steel project. Tasmania also has hopes for a steel industry of its own, based on the Savage River deposits, which are being widely drilled. Reports vary as to potential tonnage, but anticipation is in the vicinity of 100,000,000 tons. Grade is not considered to be high and beneficiation is regarded as necessary.

Oil.—Encouragement has been given to the search for oil by the discovery of a small flow of oil in Australian Oilfields No. 1 well at Combarngo, 60 miles from Roma, in Central Queensland. This locality has achieved prominence by the location of flow oil at the rate of some 80 barrels per day at the Cabawin well in the same locality. The oil was of 48° gravity, the highest grade so far located in Australia, and the discovery was regarded as one of considerable promise and as pointing to the petroliferous possibilities of that region of the Great Artesian Basin. The oil in the Combarngo well is 52° gravity and although the flow between 4,109 ft. and 5,185 ft. is small it is regarded as a very satisfactory pointer in the search. The discovery was accompanied by a make of 100,000 cu. ft. per day of petroliferous gas.

Arrangements have been made between Associated Australian Oilfields and its associates for the sale to H. C. Sleigh, Ltd., of a 10% undivided working interest in all the areas of the group for the sum of £A700,000 to be contributed over a period of seven years. The money will be used for exploration, mainly in the areas held by the group in Queensland which total some 125,000 sq. miles.

The Minister for National Development has stated that two helicopters are to be used by his department for gravity surveys in the Amadeus, Georgina, and Great Artesian Basins. It is expected to fly some 50,000 miles in a period of 18 weeks. A base camp will be established near Alice Springs and it is intended to cover an area of 100,000 sq. miles in Western Queensland, Northern Territory, and South Australia.

Mount Isa.—As part of its expansion programme Mount Isa Mines has let a contract for £A1,500,000 for the construction and installation of winding plant at a new ore shaft. The contract covers three hoists of 12,800, 6,400, and 700 peak h.p. respectively for skips, cage, and auxiliary. Erection is to be commenced in September, 1962, and to be completed in May, 1964. A steel headframe is to be built 200 ft. high. The shaft is to be 24 ft. in diameter inside the concrete lining and will have an initial depth of 3,250 ft., but will be sunk ultimately to 4,000 ft. A total of 8,000 tons of ore per day is now being hoisted through the present shaft, but the planned ore-hoisting capacity of the new shaft is 14,000 tons per day.

Export of Ores.—Export of ores to supply the demands of the Japanese market continues to command attention and possibilities are put in the region of £A8,000,000 or more per year. Export of copper concentrates would seem to have reached its maximum, however, with little prospect of any material addition, the big field now being in coal which is available in the required quantity. The difficulty facing this trade is the inability of the coal ports to accommodate and load the large colliers intended for this export. Coming months should see active work in the provision of coal loading equipment and port facilities.

Aluminium.—Interest has been aroused by the news that the Western Mining Corporation, Broken Hill South, and North Broken Hill, in association with the Aluminum Co. of America (Alcoa), are to establish an aluminium smelter at Point Henry, near Geelong, Victoria. A new steam power plant using a brown-coal deposit at Anglesea recently bored by Western Mining Corporation is to be used. Alcoa of Australia Pty., Ltd., is to mine bauxite in the Western Mining Corporation's leases in the Darling Ranges, Western Australia, while the bauxite will be treated at a plant to be erected at Kwinana, close to a deep-water port on Cockburn Sound, 15 miles south of Fremantle and adjacent to the proposed site of the Broken Hill Proprietary Co's. Western Australian steelworks.

British Aluminium, which holds extensive bauxite leases in the Northern Territory, is expected to become active. Extensive investigation has been in progress since the termination of the Corporation's partnership with Consolidated Zinc in Comalco. Queensland reports that representatives of aluminium interests are visiting Gladstone to investigate the possibility of establishing an aluminium industry there, based on thermal power generated on the Callide coalfield. It is reported that the visiting engineers are from the British Aluminium Co. and Aluminium, Ltd.

The capacity of the Bell Bay, Tasmania, aluminium works is to be increased from 12,000 tons to 44,000 tons of primary aluminium per year. Aluminium oxide will be supplied from the

Weipa bauxite deposit of Comalco. The great increase in smelter capacity has resulted from negotiations with the Tasmanian Government which involve the provision of additional power from the Derwent scheme available since 1956.

FAR EAST

June 15.

Malaya.—Speaking at the annual meeting of the F.M.S. Chamber of Mines, held in Ipoh on May 24 last, Mr. D. R. Mitchell the president, said that " the present altered outlook for tin has brought into sharper focus the anxieties concerning the availability of new mining land and the future maintenance of Malaya's productive capacity of tin ". By the end of March this year, six months after tin export control had been lifted, the number of active producing units was 71 dredges and 539 other mines, as compared with 76 dredges and 662 other mines in December, 1957, at the time when tin export control was introduced. The reduction in the number of active producing units over this period of $3\frac{1}{4}$ years " is due entirely to the shortage of new mining land ", he added. " Whilst it is expected that the increase in the price of tin over the past few months will stimulate output, one would not forecast Malaya's total production for 1961 at a figure higher than 55,000 tons of tin-in-concentrates ", said Mr. Mitchell. In the general, long-term sense " it does now appear that unless in future there is considerably less demand for tin than at present, consumption can only be met by production from deposits of a lower grade than those considered economically workable at the present time. This, of course, requires higher prices of tin in the future ".

Mr. Mitchell said : " Scarcity of new mining land is by far the gravest problem facing our industry at the present time, and the altered statistical position of tin has made this all the more obvious ". In general State Governments had adopted a fairly liberal policy towards the issue of prospecting permits over state land not scheduled for other uses and situated in localities where mining would not conflict with agriculture and other interests. It often happened, however, that those areas which mining concerns would most like to prospect were not available, either because the land lay upstream from some form of agricultural development, or because it had been gazetted as a Malay reserve, or for some other reason. Mr. Mitchell added that " we miners realize that we cannot expect to be granted prospecting permits over every piece of land we would like to test. But what we do ask is that prospecting permits should always be granted, and without undue delay, unless there are compelling reasons for refusing the application ".

Malaya exported 76,366 tons of tin (blocks, ingots, bars, or slabs), valued at more than (Malayan) $506,000,000, last year, according to Government statistics now available. The U.S.A., the top customer, received shipments from Malaya totalling 29,616 tons in 1960 (22,860 tons in 1959). Japan came next with 10,796 tons in 1960 (8,565 tons in 1959), followed by West Germany 6,832 tons (110 tons), Belgium 5,280 tons (nil), Italy 3,625 tons (2,613 tons), India 3,263 tons (3,616 tons), France 2,961 tons (382 tons), and United Kingdom 2,815 tons (102 tons).

The Sultan of the State of Pahang in Malaya holds the lease for the 1,436-acre site on which the Bukit Bangkong iron-ore mine, 14 miles from Kuantan, Pahang, has started operations. The mine is being worked by South-East Asia Mining (Malaya), Ltd., which has offices in Kuantan and Singapore and is represented in Japan.

A spokesman for the Fuji Iron and Steel Company was quoted in Tokyo as saying that nine Japanese steel mills had concluded negotiations to import a large amount of iron ore from Malaya on a three-year contract. They would import 9,000,000 tons of ore from the Dungun mines, in Trengganu State and 4,000,000 tons from the Rompin mines, in Pahang.

Last year Japan imported nearly 5,374,000 tons of ore valued at (Malayan) $137,000,000 from Malaya. This was the bulk of Malaya's iron-ore exports, which totalled some 5,500,000 tons, 75,000 tons having gone to Holland, about 42,500 tons to Formosa, and more than 8,500 tons to West Germany.

India.—Uranium deposits have been reported found in the Udaipur district of Rajasthan and detailed exploration is being conducted there by the Department of Atomic Energy.

Another oilfield has been found in the Cambay region of India at a place called Kalol, which is about 15 miles from Ahmedabad, This was announced recently by Mr. K. D. Malaviya, India's Minister for Mines and Oil. It was stated that the oil was flowing from the field smoothly, without giving any trouble. It was, however premature to talk about the exact size of the oilfield.

SOUTHERN AFRICA

June 28.

Affairs in the New Republic.—In his inaugural address the president of the Republic of South Africa, His Excellency C. R. Swart, stated that in terms of the new constitution he will no longer act as representative of the real Head of State but will act in his own right and on behalf of the Government and people of the Republic. Later, in his address to Parliament, the State President set out the following Government programme : Expansion of such State-sponsored undertakings as the South African Iron and Steel Industrial Corporation, the S.A. Coal, Oil, and Gas Corporation, and the Electricity Supply Commission, domestic processing and refinement of raw materials, the training and full utilization of the country's human potential, and the promotion of internal unity and of international understanding of the Republic's policies. The expansion programme of the enterprises mentioned will involve an expenditure of R2,000,000,000 over the next 12 years—which will contribute appreciably to the strengthening and stimulation of the economy as a whole.

In its quarterly review the S.A. Reserve Bank pointed to indications that, excluding seasonal changes, the gross national product continued to increase from the fourth 1960 quarter to the first 1961 quarter. This was reflected in a substantial increase in consumption as against a decline in gross domestic saving, both personal and corporate. Following the announcement of stricter import control measures retail sales expanded considerably. While the net current surplus with the outside world improved by about R6,000,000, a decrease occurred in gross domestic capital formation, mainly reflected in reduced investment in inventories. According to indexes available for various economic sectors, bank debits and building plans passed declined substantially in the first quarter ; the value of property transactions and commercial bank discounts and advances decreased slightly ; railway earnings showed no change, but Stock Exchange turnover, gold production, imports, exports, and retail sales improved.

On June 16 exchange control regulations were amended to provide that all residents in the Republic shall declare to the Treasury any assets held abroad, when and how acquired, where held, and whether and to what extent such assets are held in cover for or in respect of any external liability. The sale, transfer, or otherwise disposal of such assets can now be transacted only with Treasury consent and in accordance with its conditions. However, the Treasury has powers of exemption from these regulations. This drastic measure followed on the suspension of forward currency dealings by residents to cover Stock Exchange transactions and consumer goods importation. While this has meant in effect isolation of the country's Stock Exchange it should be read in the light of recent trends in the country's gold and exchange reserves.

Mine Labour.—In 1961—as in 1960 and 1959—the coal-mining industry is expected to have a native labour complement adequate for all its requirements. The position of the European complement, however, is less satisfactory. In the recent past the shortfall could not be met from immigrants, but, more recently, Government policy and attitude towards encouraging immigration has undergone a change, the practical effects of which are still to become apparent. In a break-down of the industry's sales it has been revealed that in 1959 and 1960 sales to the railways declined to about 6,382,000 tons from the 1958 figure of close on 7,000,000 tons. The reduction is attributed to the extension of electrified and diesel traction.

Blyvooruitzicht.—The lease area of Blyvooruitzicht Gold Mining is situated for the greater part in the southern zone of a natural water compartment formed and bounded on its four roughly rectangular sides by two north-south post-dolomite dykes about 4½ miles to 9 miles apart, on the north by an east-west pre-dolomite rock formation, and about 12 miles to the south by an east-west post-dolomite rock formation. Rain water, seepage in the dolomites from the north-east and east, and the overflow of ground water from the east across the eastern north-south dyke, make up the inflow into the compartment. Much of this water penetrates into the workings along fault and dyke planes and through fissures. The mine pumps to surface about 12,500,000 gallons daily and, since legislation prohibits disposal beyond the boundaries of the owner's land, means must be found to dispose of any surplus above what can be used in surface operations. This surplus amounts to about 6,500,000 gallons a day, which constitutes a recurrent circulation of water between underground and surface. The mine has to dispose of the surplus by returning it to the compartment on its own property. Boreholes 8 in. in diameter are drilled to intersect underground cavities and where this has been achieved the holes are cased and water transferred down to the cavities. Of 35 holes drilled 32 intersected cavities between 150 ft. and 250 ft. below surface. Fluorescene and sodium chloride added

to the water has showed up in the underground water ten days after addition. In an attempt to seal off the fissures feeding into the underground workings from the cavities screened sawdust and fine grass is being added to the flow through the cased holes. Final results of the method are not yet available, but sawdust has been detected in boreholes 1,600 ft. and 3,000 ft. from the nearest point of application—indicative of a wide lateral distribution and some stability in the pumping rate. One interesting point about fissure seepage is that, whereas in the early stages of stoping very little water was encountered at the advancing stope faces, later large quantities started entering the workings—both from the hanging- and foot-walls. This is attributed to opening up and possibly connecting up of fissures in the formations above the workings and in and with the fissures of the fracture zones or domes above and below the workings or excavations. Prior to installing adequate underground pumping capacity that fissure inflow was countered by cementation through holes drilled above and below the workings in the stopes at injection pressures of 4,000 lb. per sq. in. In development, however, cementation has been sustained to lessen the immediate hazard of intersecting water under high pressure and to delay the necessity of pumping water for several years, until such time as stoping is conducted.

There are many interesting features about the No. 4 Blyvooruitzicht shaft, situated in country rock just north of the sub-outcrop workings. Sites within the area of the workings were discarded for the reasons that the shaft pillar would lock-up high-grade ore for a very lengthy period, that a lengthy surface haulage system would be required, and that the fracture zone due to mining operations would eventually break into the shaft walls and give rise to the possibility of water inflow, if not flooding. The country-rock site was selected since, although men, ore, and material would have to be transported over a distance, applicable also to the maintenance of services and traversing of air, there were the advantages of containing no payable ore in the pillar, and of relative proximity to No. 1 shaft upper workings to permit of an access cross-cut. The 26-ft. lined diameter No. 4 shaft is divided into three compartments by one major bunton system and a minor bunton system from the centre of the former to a shaft wall-bracket. The large compartment carries two double-deck 14 ft. by 6 ft. man-cages, two sets of four pump columns each, and permanent electric cables supported on a wall bracket. The two smaller compartments carry an 11½-ton skip in each, with a mud-column in one and an air-column in the other compartment. The cages run on rail-guides and the skips (bottom discharge) are fitted with hat-guides, generally with a minimum of supporting steel work. Some guides are carried on wall brackets; cables and columns are supported on channels on the shaft walls; column bearers are built into the shaft lining and secured to the rock mass. All supporting steelwork has been eliminated except for one bunton and a stiffener. Instead of I-beam buntons a design of pointed hollow steel section has been adopted, which has a lower friction factor and does not retain spillage. Tests indicate that in the No. 4, the water-gauge loss will be about 2 in., against 7-in. to 8-in. in shafts of more conventional design and fitted with I-beams, when downcasting at 700,000 c.f.m.

The No. 4 reinforced headframe, 237·5 ft. high, is designed to incorporate, in addition to the usual bins, a screening plant making use of gravity and vibrating conveyors, considered more efficient than conventional practice wherein rock is discharged into bins and then lifted again into the screening plant *via* conveyor-belt systems. The layout provides for the ground-level installation of the automatic rock winder in the same building with the main winder, thereby effecting a 50% reduction in operating personnel. The height of the headframe provides the necessary efficient rope-fleeting angles for automatic winding, as well as the structural conditions for the screening and ancillary plant.

The headframe design conforms to a soil which for all practical considerations could only take a bearing pressure of 1 ton per sq. ft. The headframe is carried on the shaft lining as a deep planted pole, with struts extended back to the main winder and platform hoist foundations, to reduce deflection at collar level. Two struts were constructed in the form of concrete tunnels—one to the main winder foundation being 10 ft. by 8 ft. i.d. with 1-ft. reinforced concrete walls; the second tunnel being 6 ft. by 4 ft. also with 1-ft. walls. To distribute the load from the struts a 6-ft. slab was cast round the complete collar excavation just below collar level. Uneven distribution of the loading on the circular shaft results from the headframe square section, the circular shaft, and the greater dimensions of the former over the latter. This uneven distribution coupled with the moment produced in the headframe by the ropes causes torsion in the headframe base, which is accompanied by the wind effects. A circular toroid of reinforcement was designed to accommodate this torsion.

The concrete headframe was constructed by

the Siemcrete patent method of sliding shuttering. The soil conditions necessitated the pole design which was therefore designed to be of a length never less than the headframe height, constructed at a rate matching that of the sinking. To a depth of 250 ft. the lining is 3 ft. thick, gradually reduced to 18 in. from 250 ft. to 300 ft. with a corresponding reduction in the reinforcement. The design provides for a " break " between the pole and the lower shaft lining at 300 ft. The weigh-batched concrete mix for the headframe and foundations is : 515 lb. cement, 1,400 lb. sand, and 1,660 lb. stone, with water to produce 2-in. slump, 1½ in. coarse aggregate being used and the concrete vibrated. The design strength is 3,750 lb. per sq. in. at 28 days.

Transvaal.—At Durban Roodepoort Deep the No. 5A sub-vertical shaft is nearing full commissioning for operations in the deeper levels of the Main and South reefs in the eastern section, where the reefs dip almost vertically.

At East Rand Proprietary Mines the G and H pilot winzes sunk on reef in the Central Section were stopped temporarily due to mining difficulties and lower values and compensating operations are being accelerated in other sections. The company reports that these winzes appear to have passed out of the main zone of good values stretching across the deep levels of the property. However, recent development at depth is giving some encouraging results in both the Eastern and Western Sections. According to the latest available information the G winze had reached a point a little less than 2,000 ft. from the southern boundary and the H winze a little more than 1,000 ft. therefrom. The depth of the H winze was then about 11,250 ft. below surface. These two winzes are the deepest of the system of six winzes advanced to explore the reef bodies at depth. At the recent Commonwealth Congress discussion of the paper by F. G. Hill and H. G. Denkhaus on rock mechanics research in South Africa disclosed two points of immediate practical reference. One referred to the condition that de-stressing operations in stopes was proving less effective as workings deepened. It was stated in the discussion that a possible solution may be found in drilling holes longer than 10 ft. The second point related to the amount of support required in stoping areas. Provision of this is a major item in the working cost accounts. At E.R.P.M. support in the longwall stopes consists of four-pointer timber chock packs, constructed of 32-in. slabbed timber with a 5-in. rise. Spaced 6 ft. on dip, these packs are in rows 6 ft. apart, the angle of the rows being 25° off true dip and inclined towards the face. Scatterwalls of large fragments—subsequently removed—are built up between the packs near the face to confine and concentrate the blasted rock in the working area near the face. In addition, permanent waste walls are built up from waste blasted in advancing hanging-wall gullies immediately below each gully. The principle of support, particularly near the face, is that it should be sufficient to control the effects of a burst. Notwithstanding this support sagging generally occurs in the back areas. The question arises whether or not it is better to have a large amount of support in the stoped areas or whether or not safer conditions, also more economic operations, might not result from allowing hanging to settle more quickly on to the foot-wall. In other words, should only sufficient support be provided to render the working area near the face safe ? Research is proceeding in an attempt to ascertain the effect of support on abutment pressure.

Union Corporation.—The Union Corporation has stated that under existing circumstances, commitments, which normally would have been shared with the investing public through the medium of the Stock Exchange, may now have to be carried by the corporation in their entirety. Among these commitments is its proportion of the uncalled capital of the Bracken and Leslie mining companies, amounting to R12,600,000. However, from its own resources and through a short-term loan of R4,000,000, the corporation expects to be able to meet the calls on it, which should have high long-term returns. In the short-term the corporation will be restricted in pursuing new projects and undertaking new commitments. The corporation has formed Unicorpora, Ltd., to handle, from its own resources and credit worthiness, its existing overseas interests and the development of new projects, since it cannot rely on funds available in South Africa. Exploration in the Kinross field had not been carried to the point where it could be said a fourth mine would be established in that field.

Orange Free State.—In a general review of the gold mines of the Free State, prepared by the companies in that field, it was stated that, due to the thickness of the lavas, the geothermic gradient averages 1° F. per 130 ft., against a similar rise for every 212 ft. in the Witwatersrand mines. At Free State Geduld virgin rock temperature of 108° F. at 5,300 ft. was reported ; 110° F. at 5,200 ft. in the Loraine mine ; at 7,400 ft. in the President Brand mine 124° F. was recorded, similar to that at a depth of 11,000 ft. on the Witwatersrand. At the collar

level at 4,400 ft. in the latter mine, from which level twin sub-vertical circular shafts have been sunk, a 2,400-ton refrigeration plant is to be installed. In some mines 300-ton refrigeration plants are used for reconditioning return air for re-use in stopes. In some development ends 30-ton spot coolers are used. Some of the original shafts in the field—460 sq. ft. rectangular units and bratticed for up- and down-cast ventilation—circulate about 500,000 cu. ft. per min. at 12 in. water gauge. The more efficient circular shafts handle greater quantities, a typical 20-ft. lined-diameter unit being equipped to upcast-1,250,000 c.f.m. at 18 in. water gauge. The Harmony ventilation installation—one of the world's largest—has four fans of a total 10,000 h.p. and capable of up-casting 1,800,000 c.f.m. at 32 in. water gauge.

With rapid holings wanted between the first two shafts sunk, to comply with statutory requirements of a double-outlet from each mine, the twin-end system was often adopted. Due to its inherent flexibility this system has proved of great value in exploration and subsequent stoping of block-faulted areas or when large quantities of air are required owing to methane gas or difficult ventilation conditions. The twin-end system consists of a haulage and return airway, spaced about 50 ft. apart with inter-connecting cross-cuts every 400/500 ft., the air being coursed through the last of the cross-cuts. Air is forced to the faces by electric fans and piping. From bays in the side-walls long horizontal pilot cover holes are diamond-drilled ahead of the faces and cementation effected where water is encountered. In driving the ends the strength of the technique lies mainly in the organization, training, and teamwork of the native labour. The comparatively simple equipment consists of 2·75-in. jackhammers with airlegs and fitted with $\frac{7}{8}$-in. T.C. integrally tipped steel. A rail-mounted drill-carriage serves as platform for drilling the upper holes. Blasting is by 60% explosive; cleaning by a small rocker-shovel loading 4-ton side-discharge cars hauled on 45-lb. tracks. This equipment is typical of a 10 ft. by 10 ft. haulage. Where the overlying khaki shale is troublesome development on reef is restricted. In such cases, since the maintenance of reef drives over any lengthy period is expensive, foot-wall haulages are advanced in strong quartzites, with cross-cuts and reef raises every 400/600 ft. Use is now being made of raise-climbing equipment to develop the ore-pass systems with concomitant economies.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Electronic Belt Weigher

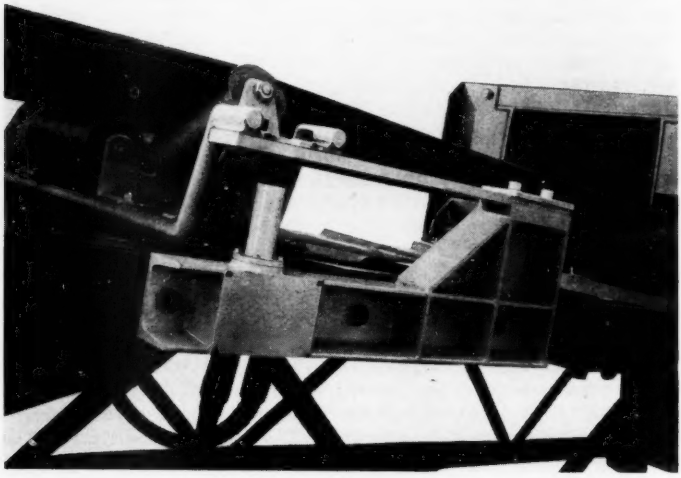
Particulars were released last month of a continuous electronic belt weigher. The weight of the material carried is recorded in a counter in units to suit any requirements. The machine is accurate to within 0·5% even with a badly-loaded and out-of-track belt and it comprises three basic units.

The weighing section which consists of two cantilever arms, positioned one on either side of the conveyor. These carry the weigh idler at one end and are attached at the other end to the side frames. In turn, the side frames are bolted to the conveyor stringers. Any material on the conveyor-belt deflects the arms in proportion to the weight (normally about 0·05 in. for a fully-loaded belt). This deflection is transmitted to the armatures of differential transformers which produce a small alternating voltage, the amplitude of which varies linearly with the deflection—*i.e.*, with the weight of material on the belt.

The tachometer generator is driven from the underside of the top belt. Its function is to produce the energizing current for the weighing transducers. Thus the weight and belt speed are multiplied to produce a resultant flow rate signal. The transducers are adjusted during calibration to give zero signals with the conveyor-belt running empty.

The integrating and totalizing unit. The signal from the weighing section is amplified and supplied to an integrator motor. Linear and

Craven Electronics Weigh Idler Unit.



stable amplification is achieved by negative feed-back. The integrator motor has a disc incorporated which rotates at a speed directly proportional to the signal (and is therefore proportional to the instantaneous deflection of the weigh idler section and belt speed) and produces pulses whenever the disc rotates—*e.g.*, when material is passing over the conveyor. This is accomplished by means of light passing through holes in the disc and striking a photo-electric cell. A given weight is therefore made to produce a definite number of pulses in a given time. A printing counter is actuated by the pulses from the integrator motor and records flow rate of material over the conveyor. Printing facilities are available on a tear-off paper strip. The standard counter has six digits and will give a maximum reading of 999,999. The standard reading is to one decimal place. Provision for reading to two decimal places can be made if required. A low-level cut out is incorporated to eliminate counting pulses should there be any variation in the weight of the empty belt. A switch is provided to isolate if necessary.

These notes are from the makers **Craven Electronics, Ltd.,** of Victoria Works, Bingley, Yorks., associated with **Richard Sutcliffe, Ltd.,** of Horbury, Wakefield.

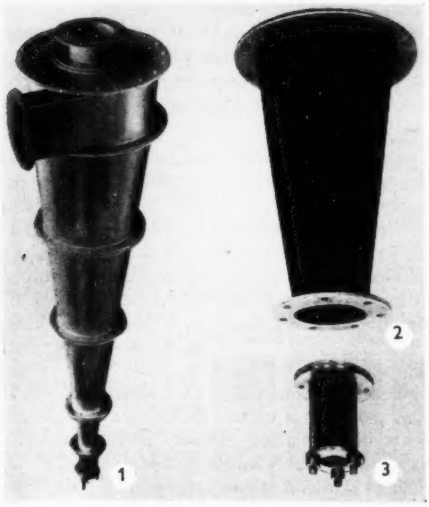
Large Capacity Hydrocyclone

The illustration (Fig. 1) shows a 600 mm. diameter Mark 3B hydrocyclone of special design for large capacities at low pressure drops by **Liquid-Solid Separations, Ltd.,** of 2, Anderson Street, London, S.W. 3. It is of fabricated mild-steel construction, sectionalized, and fitted with (Fig. 2) replaceable liners of special abrasion-resistant rubber, thus greatly simplifying maintenance, the vortex finder also being rubber-covered and interchangeable.

The "Multi-Disc" apex nozzle, shown in Fig. 3, consists of a moulded section of special abrasion-resistant rubber with a cylindrical external and a conical internal form, parted off into a series of discs, in this case 6 mm. or 12 mm. thick, and contained in the apex nozzle holder. By removing or replacing these discs the internal diameter may be adjusted in steps of 1 mm. or 3 mm. over a range, for example, of 24 mm. to 75 mm., giving great delicacy of control over this critical orifice without interference with the correct conical internal form.

The relative small included angle of the hydrocyclone apex (14° 14′) results in both a lower pressure drop for a given capacity and a finer separation, as compared with the conventional 20° wet cyclone, thereby effecting material savings in pumping costs.

These units are also available in diameters of 15, 30, 75, 150, and 300 mm., the bodies being normally of cast aluminium with similar replaceable liners and "Multi-Disc" apex nozzles. In most instances both interchangeable vortex finders of different diameters and interchangeable body liners with different area-feed inlets can be supplied, giving great flexibility of



control over both pressure drop and size of separation; 15 mm. and 30 mm. Multihydrocyclones, consisting of batteries of these units for separations down to 5μ, in suitable cases, at plant capacities, are also available.

Precision Indicator of the Meridian

We were recently afforded an opportunity of visiting the Instrument Wing of **English Electric Aviation, Ltd.,** at Stevenage, Herts, where work which calls for a new scale of engineering accuracy (" tolerances measured in millionths of an inch ") is called for. An example of the kind of instrument being studied and produced and one which may be of interest to mine surveyors is the P.I.M. system or Precision Indicator of the Meridian.

First, however, a word about the factory itself. The Instrument Wing was first set up by the company as part of the plan to build comprehensive facilities for the manufacture of complete guided weapons systems. At first the Wing developed and produced relatively simple and large displacement and rate gyroscopes for Thunderbird, the British Army's ground-to-air missile. Later, when development of the Blue Water missile for the Army was ordered, it was necessary to take out a licence with the Minneapolis-Honeywell Co. of the U.S.A. for the manufacture and development of their 7-oz. miniature integrating gyroscope (the MIG). It has now been in production at Stevenage for two years and is the only miniature inertial quality gyroscope being made in Europe. The starting work on the MIGs coincided with the decision to expand the Instrument Wing into a factory with the most advanced and comprehensive facilities for this type of work in Europe. Dust is excluded by filtering the air as it enters the building, while the temperature is kept at 72° F. and humidity at between 35% and 45%.

Because the instruments are extremely sensitive special precautions have been taken to ensure that they are isolated from all vibrations. The wing is a single-storey building, which helps to reduce vibration caused by high winds, while all moving machinery, including the air-conditioning and cleaning plant, is 80 ft. away and all connexions for air filtration and temperature and humidity control are by flexible overhead ducts. All other sources of vibration—express trains on the railway a quarter-of-a-mile away, footsteps in the corridors, or nearby road traffic—are excluded by testing the instruments on concrete plinths attached to 50-ton concrete blocks supported on inflated rubber bellows. Below the rubber bellows are further blocks of concrete embedded deep in the foundations.

The P.I.M. system, already referred to, exploits the extreme sensitivity of the floated rate integrating gyroscope to detect north within one minute of arc by sensing the horizontal component of the earth's rotation. The gyroscope used in P.I.M. is so sensitive that it can detect a turning rate equivalent to one rotation of the earth in 20 years. The gyroscope is mounted under a theodolite (Fig. 1) so that its input axis is horizontal and in the same

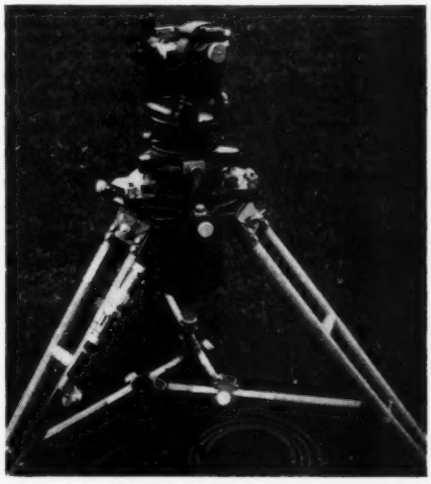


Fig. 1.

Fig. 2.

vertical plane as the axis of the theodolite telescope. The gyroscope is directly coupled to the theodolite head and rotates with it.

The component of the earth's rotation about the gyroscope input axis is termed the input rate and is proportional to Cos λ Sin θ, where λ is the angle of latitude and θ is the angle between the gyroscope input axis and a line running from east to west. The input rate is therefore zero when the gyroscope input axis lies on an east-west bearing.

A sensitive meter measures the input rate and theoretically the input axis should lie east-west when the meter gives a null indication. In practice the null indication is obtained on a bearing which is a small angle north or south of the east-west line, this error being caused by a slight systematic bias in the gyroscope.

To eliminate the bias error a null indication is first obtained with the input axis lying approximately east. The gyroscope is then rotated through about 180° and a second null indication is obtained. The azimuth bearing at each position is noted. The bias of the gyroscope will affect each bearing equally but in a reverse sense—*i.e.*, if the first bearing is 1° north of east, the second bearing will be 1° north of west. True north can therefore be determined by bisecting the angle between the two bearings.

The present system consists of the following equipment :—(1) A sighting unit comprising :—(*a*) A rate integrating gyroscope Type GG37, which is used as a sensitive rate gyroscope. (*b*) A thermostatically-controlled oven, which totally encloses the gyroscope. (*c*) A standard Watts microptic theodolite No. 2 adapted for attachment to the gyroscope and oven. (2) A rigid braced tripod on which the sighting unit is mounted. (3) A control unit containing the associated electronic equipment and voltage controller which is mounted in the lid of the control unit (Fig. 2). (4) Batteries (not normally provided with the equipment).

Rock Mechanics

Basic research on the mechanical properties of rocks is having an important effect on excavation practice in mining and civil engineering it is suggested in a recent publication. The laboratory study of subsidence, in the design of pillars, and in the design of shaft linings, insets, and bottoms are among those considered in mining. To meet this need **Soil Mechanics, Ltd.,** of 65, Old Church Street, London, S.W. 3, have formed a new company—**Rock Mechanics, Ltd.,** which will specialize in solving these and related engineering problems. An illustrated booklet gives particulars of the facilities available and points out that many of these derive from earlier work on soil mechanics. Two examples are given of work in mines, one at Kit Hill, Cornwall, and the other at Greensides Mine, Cumberland. The information obtained was required to assist in the evaluation of explosive tests and the following properties were determined :—Elastic moduli, damping characteristics, thermal properties, specific gravity, density and moisture content, and petrological analysis.

Personal

P. H. ANDERSON and A. A. VON MALTITZ have been elected vice-presidents of the Transvaal and Orange Free State Chamber of Mines.

H. F. BANKS, vice-principal and head of the Department of Mining, Doncaster Technical College, was made M.B.E. in the Birthday Honours.

D. W. BISHOPP has joined the South African Geological Survey in Pretoria.

C. M. G. BOLTON is returning from Irak.

H. R. BROOKER hitherto general sales manager, joined the board of Johnson, Matthey, and Co., Ltd., on June 15, 1961, as a joint managing director of the company.

P. H. A. BROWNRIGG has been appointed a director of Anglo American Corporation of South Africa, Ltd., and is to assume the local direction of the Corporation's Rhodesian affairs from July 1 in place of Mr. Keith ACUTT, a deputy chairman of the Corporation who is moving to London.

A. E. BURTON-PAGE is home from Ghana.

F. N. CHOLMELEY has left for India.

G. C. L. CLARK, president of the Australasian Institute of Mining and Metallurgy, was made C.M.G. in the Birthday Honours.

J. DAMEN has returned to Holland from Liberia.

A. G. DARNLEY was awarded the "William Frecheville" student's prize of the I.M.M. for 1959–60.

G. R. FISHER, chairman of Mount Isa Mines, was made C.M.G. in the Birthday Honours.

M. L. FITZGERALD was awarded the "The Consolidated Gold Fields of South Africa, Ltd.", Premium of Forty Guineas for the session 1959–60.

W. E. FITZPATRICK has been appointed manager of North Broken Hill, in succession to the late Mr. A. R. WEST.

G. HARVEY is home on leave from Ghana.

G. JENKINS, H.M. Senior District Inspector of Mines and Quarries, was awarded the I.S.O. in the Birthday Honours.

H. C. KOCH has been elected president of the Transvaal and Orange Free State Chamber of Mines.

R. W. MCCALLUM is home after two years in Bolivia and Colombia.

P. D. R. MALTBY was awarded the "Arthur Claudet" student's prize of the I.M.M. for 1959–60.

K. A. PHILLIPS was made M.B.E. in the Birthday Honours.

B. PIKE has been made a director of Ipoh Tin Dredging.

R. N. PRYOR was awarded the "The Consolidated Gold Fields of South Africa, Ltd.", Gold Medal for the session 1959–60.

CHARLES M. ROMANOWITZ has opened a consulting office at 2034, Santa Clara Avenue, Alameda, California, and is available for consultations in dredge application and operation.

FRANK A. SEETON has been appointed manager of the Metallurgical Operations Division of the Denver Equipment Company.

E. D. SHEARN was re-elected chairman of the Council of the Malayan Chamber of Mines, and J. N. DAVIES re-elected vice-chairman for the current year.

D. J. SKIDMORE, production director, Scottish Division, N.C.B., was made O.B.E. in the Birthday Honours.

A. M. STARR has left France for Ghana.

M. L. SOUTHWOOD JONES is now in New South Wales.

J. A. S. THOMAS is home from Ghana.

E. W. THIEL has been appointed consulting engineer to Rand Mines, Ltd.

J. B. WALL is shortly returning from Tanganyika.

T. MUIR WARDEN has been made a director of Beralt Tin and Wolfram, Ltd.

GILBERT WILSON has been awarded the "William Bolitho Gold Medal" of the Geological Society of Cornwall.

W. H. WILSON was here from India.

B. B. YOUNG is leaving for Ghana.

A. R. WEST, director of North Broken Hill, Ltd., and the mine manager, died on June 9.

Metal Markets

During June [1]

Copper.—Copper has suffered badly in June from not having any positive lead from outside events. There has been a welter of minor, and all too often contradictory, reports about impending developments of various sorts—mostly strikes, of course !—but no clear lead as to the likely trend of events. To make matters worse, the general economic outlook in a number of directions has been most confusing, while for Great Britain, poised on the brink of the Common Market, confusion has been worse confounded. The natural outcome of all this uncertainty has been that prices for copper [2] have fluctuated, at times relatively widely and sharply. This is, of course, a handicap for the consuming industries, as it calls for rather frequent adjustments of semis prices, but another way of looking at the matter could be that the various self-balancing features built into the London market have ensured that at least prices have not got out of hand at any time.

Fortunately the situation is not likely to be extended much longer, as one of the more celebrated causes for uncertainty, the threat of a strike at the U.S. facilities of Kennecott Copper on July 1, was finally resolved in the early days of July, when a new wage agreement was negotiated. On the other hand, this now makes a soft copper market for the remainder of the summer a strong possibility. However, there are still the threats of strike trouble in Chile to help keep the situation confused, although it may be doubted whether prices will again be as erratic as they have been. In the Congo political harmony seems a little nearer realization, which will be a help, and although the new Rhodesian constitution has aroused strong feelings, it has not provoked any of the feared violence so far. Meanwhile, world industry statistics continue to paint an uncertain picture, the true pattern of which

[1] Recent prices, pp. 8, 48.
[2] See Table, p. 48.

will probably only be discernible when the June and July figures are available.

U.K. copper consumption in April was still at a fair level—53,976 tons, of which 39,636 tons was refined. Production of both primary and secondary refined was down that month—primary sharply to 9,626 tons and secondary almost disastrously to 7,821 tons. Stocks of refined copper topped six figures—reaching 104,648 tons—while blister stocks edged up to 22,301 tons.

Tin.—Tin has stolen the limelight in a big way in June. With the operation of this market normally under the close control of the Tin Agreement, anything out of the ordinary in tin price movements naturally attracts attention. However, when, as in June, the Tin Agreement proves to have failed in its object, excitement is really intense. As prices [1] moved up to, and held at, £880 per ton in early June calculations began to be made of the length of time the Buffer Stock manager could continue to meet all demands for tin at that level (the ceiling under the Agreement), as it was obvious precautionary consumer buying was being inflated by speculative interest. All calculations were upset, however, when, on June 20, a record turnover for a day's activity (over 5,000 tons) exhausted the Buffer Stock. While it had been evident that this event would take place some time within a week or so of its actually happening, the final event anticipated all expectations.

Naturally prices reacted sharply upwards, reaching £940 for cash after an initial delay. However, they have now settled down a good deal lower, although still well above £880. Primarily this is due to the knowledge that there are probably 4,000 to 5,000 tons of tin in the hands of speculators on which a profit must be taken and this will probably happen at anything like £940 or above. At the same time the longer-term prospect for a tin shortage has hardly diminished in the interval and the most celebrated quantity of tin which could be additionally made available—the 4,000 tons or so which the U.S. Government holds in non-strategic stocks—has not yet been released to the market. The future therefore is still a little mixed, about the only thing that seems clear being that the Tin Council (of the Second Agreement, which has now come into force) can do little to control the situation or bring prices back to £880. They are meeting as this report is being written and their decisions are not known.

U.K. April consumption was 1,675 tons, production 1,451 tons, and stocks were lower at 11,666 tons.

Lead.—Lead has remained in its groove between about £64 and £69 in June. Consumption, especially on the Continent, holds up very well and indeed is breaking records. However, what with U.S. consumption very full (despite the restriction measures that have been adopted), prices never seem to be able to stay at the top of the bracket indicated for long.[1] June provided an instance of this. After prices had slowly crept up towards £69, and hopes of £70 were beginning to be entertained, there was a sharp setback, which seemed to be partly connected with fears of Russian metal being delivered on the London market. At this level, however, there are other lead supplies that could equally be attracted to London.

U.K. April consumption was 30,805 tons and production 6,983 tons English refined. Stocks registered a net decline, those of imported falling nearly 5,000 tons to 60,818 tons.

Zinc.—All metals have tended to be pushed into the background, in the market sense, because of the fireworks in tin and zinc has certainly been most featureless.[1] The performance of the U.K. motor industry is giving cause for concern, as it is a big consumer of zinc, and this was accentuated when that industry suffered (albeit indirectly) from labour troubles in June. On the Continent the situation in this respect is a little better and a big conference of galvanizers, meeting in Switzerland early in the month, reported optimistic prospects for zinc in this outlet. It is to be hoped they will be fulfilled.

U.K. April use was 22,271 tons and production 7,136 tons (a decline that should be reversed later). Stocks rose to 65,515 tons.

Iron and Steel.—The United Kingdom steel trade has undergone a radical change in the past six months. At the beginning of the year pressure for most grades of steel was at a high rate and deliveries were protracted because of the overloaded order books. Today demand for a wide range of products is very slack and it is possible to obtain steel in a matter of a few weeks or even days. As a result of the drop in demand generally production has slipped back and in May the industry was working at only 87% of capacity. With the advent of the summer holidays and a trend to reduce large stocks of steel on the part of users and merchants, a further drop in output is likely.

Tinplate appears to be hard hit because of the disappointing sales in home and export

[1] See Table, p. 48.

[1] See Table, p. 48.

markets and it is reported that mills in this sector are working at only two-thirds capacity. The big sheet mills are working below their limits and makers of standard joists and sections are going through a difficult patch. The tube trade is experiencing mixed fortune, with some mills active and others on short-time. On the other hand, demand for universal beams and plates, particularly light plates, is still strong, while alloy and stainless steel makers also have no sales problems.

British steel has done quite well in the export field in the past few months and May shipments rose to the highest level since October, 1959. Meanwhile in June the Iron and Steel Board, in the face of persistent pressure from the steel industry, granted an increase of about 10s. a ton in the price of home iron and steel. A dissatisfied industry, however, described the advance as " totally inadequate " having regard to the recent additional cost burdens.

Iron Ore.—This year pig-iron production in the U.K. has been higher than a year ago—unlike steel, which has decreased—and consumption of iron ore has been maintained at a high level. However, total imports of iron ore have declined this year, falling to 6,442,462 tons in the first five months of 1961 from 6,813,898 tons in the corresponding period of last year.

Aluminium.—Competition for outlets continues to characterize both the national and international markets (perhaps the latter rather than the former). It therefore strikes a discordant note with some that new production projects keep coming forward in such profusion. June has seen reports of an American proposal for a sizeable new integrated production unit in Australia—a market that is designed to be fully cared for by the project of Comalco. In the U.S.A. further new production plans by a newcomer to the field have been announced, despite domestic installed capacity still being under-utilized.

However, aluminium is, in fact, still living in the future, as befits the youngest (if also the biggest) major non-ferrous metal. It is confidently felt in industry circles that all this extra metal will be needed and it is believed it is the industry's duty to ensure every extra pound that is needed can be supplied.

In the U.K. the price remains £186 per ton. While the background factors affecting costs in the Canadian aluminium industry are similar to those in nickel, market conditions on the selling side make a similar increase look less well advised.

Antimony.—Over the past month the antimony metal and ore markets have been strong but steady. Prices have been maintained at the same level as for May—that is, for 60% ore from 26s. to 28s. per unit c.i.f.; 99% regulus is still quoted at £230 per ton and 99·6% £237 10s. per ton.

Arsenic.—The general position of arsenic is still fairly dull. The price of metallic arsenic in the U.K. is still held at £400 per ton and that of arsenic trioxide at £40 to £45 per ton.

Bismuth.—The day-to-day business of the bismuth market remains interesting but outstandingly stable. The U.K. price is still nominally 16s. per lb.

Cobalt.—The cobalt market has remained quite reasonable throughout June, although the prospect of a world surplus for a long time forward is still apparent. Contract supplies of metal continue to change hands within the U.K. at 10s. 9d. per lb. and to others the price remains 12s.

Cadmium.—The current price of cadmium within the U.K. remains at 11s. per lb. The market is steady and there is still a likelihood that the price might rise, despite a reduced offtake for both colours and plating. Recent consumption figures for the U.K. have been somewhat disappointing and the metal has not so far this year inspired the favourable sentiment which has characterized it in recent years.

Chromium.—There was no change throughout June in the state of chromium metal, prices of which are still indicated in the range of 6s. 11d. to 7s. 4d. per lb.

Tantalum.—The tantalum-ore market was steady throughout June and prices remained between 1,000s. and 1,200s. per unit c.i.f. for a 60% good ore.

Platinum.—The platinum-ore market has also been somewhat steady throughout the month. The big producers continued to meet contractual demands of their customers. The U.K. price for this business remain the same at £30 5s. per oz. and imported at £27 10s. to £28 5s.

Iridium.—During the past month iridium has been extremely quiet and uneventful. We are now well into the quiet summer months and there is little change to look forward to. The U.K. price has been held steadily throughout the month at £20 to £26 15s. per troy oz.

Palladium.—Trading in palladium has been very routine throughout June. The U.K. price has been maintained at £8 10s. to £9 7s 6d. per troy oz.

Osmium.—The price of osmium remains at £17 to £25 per troy oz. This metal has continued to be quite uninteresting right through June.

Tellurium.—There has been no further rise in the price of powder in the past month, which remains at 37s. 6d. per lb. The market is still only just adequately supplied and seems as if it will remain so. Sticks are still quoted at 40s. per lb. The long-term prospects for this metal remain bright.

Tungsten.—After an extremely active period tungsten has gone very quiet. Recent day-to-day tonnages in the European market of 100 tons per week and more are no longer realized. Scheelite has been more favourably placed than wolframite. A very large quantity of Korean scheelite, some 1,200 tons in fact, was recently up for auction. Whether this has subsequently been disposed of or not by the successful tenderers remains to be seen. A quantity of 100 tons was purchased more recently at the rather high price of 124s. per long ton f.o.b. The price of tungsten is now quoted at 128s. 6d. to 132s. 6d.

Nickel.—Despite the Canadian dollar devaluation favouring Canadian exporters, and despite the prospect of nickel being in oversupply for some years ahead, now International Nickel has got its Thompson mine going, the Canadian company announced an increased price for its nickel on world markets. In the U.K. the rise is £60 a ton to £660. The company blames rising costs and cites the heavy losses it suffered when the Canadian dollar was at a premium over the U.S. dollar.

Chrome Ore.—Developments in chrome ore throughout the month have been almost nil. The market is an active one but not spectacular. There is still a large quantity of ore about and consequently prices have shown no increase. The official Turkish export price remains at $30 per ton f.o.b. Rhodesian metallurgical remains at £15 5s. per ton c.i.f.

Molybdenum.—The market for molybdenite remains as strong as it has been during much of the past two years. The recently increased price remains the same at 10s. per lb. Mo, f.o.b.

Manganese.—Until the world's steel industries start working at a much better rate the manganese market will remain rather uneventful. Prices are still indicated in the range 68d. to 71d. per long ton unit of Mn, c.i.f. The liner freight charge on Indian manganese dioxide was increased by 17s. 6d. per ton, but because of the uproar within the trade the increase was later reduced to 8s. 6d. per ton.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum, 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
June 12	880 0	889 15	239 17½	242 15	63 13¾	64 18¾	78 18¾	79 18¾
13	880 0	888 5	237 2½	239 12½	64 8¾	65 11¼	78 16¼	79 16¼
14	880 0	888 5	237 7½	240 2½	64 10	65 13¾	78 16¼	79 16¼
15	880 0	887 15	235 7½	237 7½	63 11¼	64 13¾	77 18¾	79 1¼
16	880 0	889 15	234 17½	237 12½	64 3¾	65 8¾	77 13¾	78 13¾
19	880 0	893 5	234 2½	236 17½	64 6¼	65 11¼	78 1¼	78 17½
20	880 0	894 15	231 12½	235 2½	64 3¾	65 11¼	77 2½	78 3¾
21	905 0	913 10	234 17½	238 7½	64 0	65 11¼	77 1¼	78 3¾
22	916 0	924 10	238 17½	242 2½	64 5	65 12½	77 17½	78 17½
23	931 0	935 10	235 2½	238 7½	64 17½	66 1¼	77 16¼	78 17½
26	934 0	937 15	234 7½	238 2½	65 2½	66 8¾	77 13¾	78 13¾
27	928 0	930 5	234 2½	237 17½	65 17½	66 18¾	78 16¼	79 16¼
28	937 0	938 15	234 7½	238 7½	66 12½	67 17½	79 1¼	80 6¼
29	922 0	926 10	236 2½	239 17½	66 3¾	67 8¾	79 5	80 6¼
30	915 0	918 5	232 12½	236 12½	65 1¼	66 8¾	78 7½	79 12½
July 3	912 0	916 15	229 12½	233 12½	65 5	66 6¼	77 16¼	79 1¼
4	912 0	915 10	228 12½	232 17½	64 17½	65 18¾	78 1¼	79 3¾
5	922 0	926 10	231 12½	235 7½	65 2½	66 5	78 11¼	79 13¾
6	917 0	924 10	230 2½	234 7½	64 13¾	66 1¼	78 8¾	79 8¾
7	917 0	923 10	239 7½	233 7½	64 7½	65 17½	77 11¼	78 13¾
10	916 0	924 10	230 7½	234 7½	63 18¾	65 6¼	77 1¼	78 3¾
11	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	May		June	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	144,000	91,441	142,000	88,761
Brakpan	146,000	18,355	142,000	18,577
Buffelsfontein‡	150,000	65,953	152,000	66,458
City Deep	115,000	24,064	117,000	24,045
Cons. Main Reef	44,000	9,925	43,000	8,210
Crown Mines	175,000	30,780	176,000	30,556
Daggafontein	228,000	46,092	227,000	45,871
Dominion Reef	45,500	612	44,000	490
Doornfontein‡	117,500	49,849	120,000	51,012
D'rb'n Roodeport Deep	189,000	37,202	194,000	36,615
East Champ D'Or‡	12,500	301	12,500	241
East Daggafontein	108,000	18,468	107,500	18,436
East Geduld	128,000	36,160	125,000	35,125
East Rand P.M.	252,000	55,813	240,000	55,295
Eastern Transvaal Consol	20,200	5,608	19,800	5,688
Ellaton‡	24,000	5,620	24,000	5,631
Freddies Consol	65,000	12,904	65,000	12,927
Free State Geduld	98,000	85,604	98,500	85,942
Free State Saaiplaas	56,000	15,123	57,000	29,517
Geduld	80,000	12,920	80,000	12,882
Government G.M. Areas‡	38,000	7,456	34,000	6,652
Grootvlei Proprietary	225,000	46,532	218,000	45,142
Harmony Gold Mining	200,000	81,551	196,000	78,807
Hartebeestfontein‡	136,000	62,563	136,000	62,235
Libanon	118,000	28,786	118,000	29,517
Loraine	85,000	24,012	85,000	25,288
Luipaards Vlei‡	116,000	13,513	110,000	13,646
Marievale Consolidated	102,000	24,378	99,000	23,760
Modderfontein East	61,000	6,458	59,000	6,310
New Kleinfontein	75,000	10,380	72,000	10,081
New Klerksdorp‡	—	—	—	—
President Brand	126,000	98,910	128,000	100,135
President Steyn	110,000	41,251	110,000	41,177
Rand Leases	199,000	26,566	190,000	25,650
Randfontein‡	152,000	10,414	156,000	9,388
Rietfontein Consold't'd.	12,000	2,291	12,000	3,181
Robinson Deep	44,500	9,774	44,500	9,700
Rose Deep	23,000	3,970	23,000	4,158
St. Helena Gold Mines	194,000	67,907	187,000	65,459
Simmer and Jack	70,000	12,691	70,000	12,579
S. African Land and Ex.	112,000	22,517	112,000	22,441
S. Roodepoort M.R.	31,000	7,487	30,000	7,170
Spaarwater Gold	11,200	3,571	11,200	3,567
Springs	94,000	13,086	94,000	13,630
Stilfontein Gold Mining‡	179,000	80,550	179,000	80,600
Sub Nigel	66,500	15,049	66,500	15,036
Transvaal G.M. Estates	—	—	—	—
Vaal Reefs‡	105,500	49,322	107,000	50,023
Van Dyk Consolidated	78,000	12,468	74,000	11,472
Venterspost Gold	125,000	36,844	126,000	37,485
Village Main Reef	36,600	3,935	35,600	3,951
Virginia O.F.S.‡	138,000	27,358	142,000	28,294
Vlakfontein	53,000	19,582	53,000	19,570
Vogelstruisbult‡	81,000	17,370	80,000	17,148
Welkom Gold Mining	100,000	32,300	103,500	32,797
West Driefontein‡	157,000	132,353	175,000	137,812
West Rand Consol.‡	219,000	—	214,000	22,489
Western Holdings	173,000	118,938	175,000	120,313
Western Reefs	155,000	45,183	155,000	40,184
Winkelhaak	99,000	33,660	96,000	32,640
Witwatersrand Nigel	20,900	4,274	20,000	4,274

* 251s. 0d. † 250s. 3d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Mar., 1960	17,464,400	72 8	46 5	26 3	30,105,571
April	—	—	—	—	—
May	—	—	—	—	—
June	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	18,103,100	74 0	46 4	27 8	32,201,685
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,272,800	76 2	47 0	29 2	33,039,583
Jan., 1961	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,858,100	—	—	—	31,924,315

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
July, 1960	1,776,141	39,673	1,815,814
August	1,778,711	36,777	1,815,488
September	1,774,967	35,352	1,810,319
October	1,777,495	35,967	1,813,462
November	1,775,624	36,159	1,811,783
December	1,744,406	34,044	1,778,450
January, 1961	1,785,614	34,407	1,820,021
February	1,759,373	32,046	1,791,419
March	1,837,280	38,843	1,876,123
April	1,837,511	29,437	1,866,948
May	1,885,415	42,092	1,927,477
June†	1,887,594	35,858	1,923,452

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
October 31, 1960	368,391	33,387	401,778
November 30	367,658	33,052	400,710
December 31	364,407	32,791	397,198
January 31, 1961	384,816	33,513	418,329
February 28	396,533	33,577	430,110
March 31	398,626	33,736	432,362
April 30	398,012	34,005	432,017
May 31	396,437	33,587	430,024
June 30	392,591	33,180	425,771

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To June 24		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	24,400	4,218	4,651
Electrolytic Zinc	17,849	978	5,420
Lake George	16,197	1,172	2,456
Mount Isa Mines**	64,884	4,220	4,715
New Broken Hill	58,530	7,359	13,546
North Broken Hill	32,212	5,979	6,389
Zinc Corp.	59,500	9,267	10,816
Rhodesia Broken Hill*	—	3,812†	7,501†

* 3 Months, ** Copper 4,670 tons blister; 7,369 tons concs. ; † Metal

RHODESIAN GOLD OUTPUTS

	May		June	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	22,100	4,320	22,200	4,351
Globe and Phœnix	4,410	2,642	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	1,912	—	—	—
Coronation Syndicate	12,091	—	—	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	May		June	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	—	—	—	—
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	38,500	32,750	38,500	32,750
Bibiani	—	—	—	—
Bremang	—	—	—	—
Ghana Main Reef	—	—	—	—
Konongo	7,710	3,860	7,730	4,278
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1960		1961	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,902	29,711	47,673	22,101
February	45,754	29,895	44,164	13,250
March	45,309	29,056	52,507	7,256
April	48,607	6,847	—	—
May	47,542	62,912	—	—
June	45,884	34,208	—	—
July	44,805	33,323	—	—
August	48,284	28,931	—	—
September	48,805	38,951	—	—
October	47,473	37,308	—	—
November	46,439	33,896	—	—
December	48,778	26,327	—	—

WESTRALIAN GOLD PRODUCTION

	1959	1960	1961
	Oz.	Oz.	Oz.
January	63,924	64,794	62,434
February	65,035	66,789	73,271
March	65,408	61,941	69,360
April	62,686	65,373	62,569
May	64,184	66,682	66,352
June	74,590	74,902	—
July	78,974	67,623	—
August	68,546	67,466	—
September	66,501	68,794	—
October	70,427	67,310	—
November	68,858	107,815	—
December	117,474	76,269	—
Total	861,122	855,758	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To May 23		To June 20	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,135	7,590	14,019	7,444
Gold Mines of Kalgoorlie	37,104	11,162	40,929	9,559
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	31,052	5,691	33,675	5,383
Lake View and Star*	—	—	—	—
North Kalgurli	28,405	6,683	—	—
Sons of Gwalia	11,842	1,711	—	—
Mount Morgan	—	3,218	—	4,315

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
January, 1960	778,103	226,856	27,617	7,550,068
February	755,569	222,484	35,003	7,446,848
March	804,309	229,457	37,202	7,646,044
April	779,487	218,393	42,997	7,426,262
May	784,391	225,550	32,174	7,705,153
June	791,488	223,833	49,765	7,756,490
July	779,426	222,179	37,002	7,664,968
August	712,792	202,025	35,722	6,883,254
September	772,984	208,019	29,251	7,114,785
October	805,753	228,914	33,808	7,860,787
November	785,133	230,377	31,149	7,917,352
December	783,501	229,639	37,560	8,020,961
January, 1961	804,026	227,771	27,776	7,901,743
February	737,859	214,763	33,291	7,465,046
March	814,951	234,228	34,181	8,128,958
April	770,931	225,896	32,949	7,842,394

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	May		June	
	Tons	Oz.	Tons	Oz.
Clutha River	—	654	—	648
Lampa (Peru)†	—	35,926	—	41,448
New Guinea Goldfields	4,300	1,534	—	—
Yukon Consol.	—	$124,000	—	$274,000

† Oz. Silver : Copper, 111 tons ; 135 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1960	290,596	104,889	297,510
Provisional 1960—January	15,070	8,169	15,540
February	26,716	8,265	26,437
March	27,535	9,689	26,146
April	—	—	—
May	—	—	—
June	—	—	—
July	—	—	—
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Apr.	May	June
Ampat Tin	47	55	75
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Berjuntai	260	322	301½
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hong Fatt (Sungei Besi)	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	2½	3½	11½
Kampong Lanjut	119	161	174
Kamunting	149	179	171
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	11	10	14½
Kramat	39	37	43
Kuala Kampar	137	147½	108
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Larut	28	27	21½
Lower Perak	98	125	121
Malayan	—	—	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	632*
Pengkalen	—	—	—
Petaling Tin	90	69½	81
Rahman Hydraulic	38½	32	—
Rambutan	—	—	—
Rantau	90	84	72
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	53	29	5
Southern Kinta	360	408	426
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	—	—	28
Tanjong	—	—	—
Tekka	—	—	—
Temoh	—	—	—
Tongkah Harbour	206	—	130
Tronoh	—	—	—

* 3 Months.

NIGERIAN MINE OUTPUTS (TONS)

	Mar.	Apr.
Cassiterite	965	788
Columbite	212	162
Felspar	—	—
Gold*	66	48
Kaolin	—	—
Lead Ore	—	—
Limestone	39,815	35,574
Monazite	—	1
Tantalite	—	1
Thorite	—	—
Tin Metal	—	101
Wolfram	—	—
Zinc	—	—
Zircon	61	55

* Oz.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	May		June	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	305	55	431	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	31	—	26	—
Beralt	3	175†	3	175†
Bisichi	41½	45	39	47½
Ex-Lands Nigeria	40	—	40	—
Fabulosa	—	—	—	—
Geevor	56	—	—	—
Gold and Base Metal	62	4	—	—
Jantar Nigeria	14	24½	—	—
Jos Tin	6	—	—	—
Kaduna Prospectors	4	—	4	—
Kaduna Syndicate	23	—	19	—
Katu Tin	9	—	6	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	2¾	—	3	—
Naraguta Tin	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	147	—	118	—
South Bukeru	—	—	—	—
South Crofty	80	—	—	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	10	1	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

April, 1961.

Gold	1,871,338 oz.
Silver	186,021 oz.
Diamonds	432,202 carats.*
Coal	3,603,830 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 4,856 tons of 99·18%.
Tin	282 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,272 tons.
Chrome Ore	66,466 tons.
Manganese Ore	122,042 tons.
Lead Concs.	— tons.

* *March, 1961.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Apr.	May
Iron Ore	tons	1,134,474	1,483,898
Manganese Ore	,,	35,017	33,305
Iron and Steel	,,	44,996	47,594
Iron Pyrites	,,	13,526	28,969
Copper Metal	,,	42,077	48,566
Tin Ore	,,	1,878	6,573
Tin Metal	,,	31	191
Lead	,,	11,705	13,148
Zinc Ore and Conc.	,,	6,263	29,617
Zinc	,,	15,117	15,551
Tungsten Ores	,,	568	462
Crome Ore	,,	20,029	27,931
Bauxite	,,	44,574	32,063
Antimony Ore and Concs.	,,	—	1,814
Titanium Ore	,,	31,609	23,381
Zirconium Ores and Concs.	,,	3,885	3,066
Tantalite/Columbite	,,	43	67
Sulphur	,,	34,297	57,136
Barytes	,,	6,547	2,872
Asbestos	,,	8,973	21,728
Magnesite	,,	9,641	21,118
Mica	,,	1,627	905
Graphite	,,	708	1,677
Mineral Phosphates	,,	133,664	110,409
Molybdenum Ore	,,	628	903
Silicon	,,	511	755
Nickel	cwt.	32,495	55,398
Aluminium	,,	388,213	505,244
Mercury	lb.	216,335	200,185
Bismuth	,,	156,915	96,120
Cadmium	,,	275,399	177,318
Cobalt and Cobalt Alloys	,,	87,877	549,035
Selenium	,,	32,538	25,205
Petroleum Crude	1,000 gal.	1,005,966	1,171,069

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	104	0	0
,, ,, 80% Technical	,,	94	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	0	0
Ammonia, Anhydrous	per lb.		1	6
Ammonium Carbonate	per ton	59	0	0
,, Chloride	,,	30	2	6
,, Nitrate	,,	36	5	0
Antimony Sulphide, golden	per lb.		4	4
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98–99%	,,	42	0	0
,, Chloride	,,	45	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	10	0
Boric Acid, Comml.	,,	77	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	17	0	0
Carbolic Acid, crystals	per lb.		1	3
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2⅞
Citric Acid	per cwt.	9	17	0
Copper Sulphate	per ton	82	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		7	10
Hydrochloric Acid 28° Tw.	per carboy		15	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iodine	per kilo		17	4
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	,,	114	15	0
,, Nitrate	,,	114	0	0
,, Oxide, Litharge	,,	104	5	0
,, Red	,,	102	5	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	13	0	0
Magnesium Chloride	,,	20	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	0
Nickel Sulphate	per ton	189	0	0
Nitric Acid, 70° Tw.	,,	35	0	0
Oxalic Acid	,,	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	,,		1	2½
,, Bromide	,,		2	6
,, Carbonate (hydrated)	per ton	72	10	0
,, Chloride	,,	21	0	0
,, Iodide	per kilo		19	3
,, Hydrate (Caustic) solid	per ton	92	0	0
,, Nitrate	per cwt.	3	10	0
,, Permanganate	,,	10	3	0
,, Sulphate, 50%	per ton	21	1	0
Sodium Acetate	,,	63	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	0	0
,, Bichromate	per lb.		1	0
,, Carbonate (Soda Ash) 58%	,,	16	0	0
,, Chlorate	per ton	90	0	0
,, Cyanide	per cwt.	6	18	10
,, Hydrate, 98/99%, solid	per ton	35	6	6
,, Hyposulphite, Comml.	,,	35	0	0
,, Nitrate, Comml.	,,	Nominal		
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	16	0	0
,, Sulphate (Glauber's Salt)	,,	12	5	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	40	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	13	15	0
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	125	0	0
,, Oxide	,,	97	10	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	June 8, 1961 £ s. d.	July 10, 1961 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 5 6	2 1 3
Blyvooruitzicht (2s. 6d.)	1 6 6	1 3 6
Bracken (10s.)	1 2 3	18 6
Brakpan (3d.)	3 9	3 0
Buffelsfontein (10s.)	1 18 0	1 13 3
City Deep	12 9	12 3
Consolidated Main Reef	13 6	12 6
Crown Mines (10s.)	1 0 9	19 3
Daggafontein (5s.)	17 0	15 6
Dominion Reefs (5s.)	18 6	16 0
Doornfontein (10s.)	1 7 0	1 5 3
Durban Roodepoort Deep (10s.)	1 6 6	1 4 3
East Champ d'Or (2s. 6d.)	1 9	1 6
East Daggafontein (10s.)	8 6	7 6
East Geduld (4s.)	15 0	13 0
East Rand Ext. (5s.)	14 9	13 3
East Rand Proprietary (10s.)	1 5 6	1 2 3
Freddies Consol.	1 6	1 3
Free State Dev. (5s.)	3 6	3 3
Free State Geduld (5s.)	4 11 6	3 17 6
Free State Saaiplaas (10s.)	7 0	6 3
Geduld	2 6 6	1 18 3
Government Gold Mining Areas (3d.)	2 0	1 6
Grootvlei (5s.)	18 0	16 0
Harmony (5s.)	1 3 6	1 0 3
Hartebeestfontein (10s.)	2 5 9	2 1 3
Libanon (10s.)	12 9	11 3
Loraine (10s.)	19 0	16 0
Luipaards Vlei (2s.)	8 6	7 6
Marievale (10s.)	1 5 0	1 3 9
Modderfontein B (3d.)	1 3	1 3
Modderfontein East	8 6	7 0
New Kleinfontein	5 0	4 0
New Pioneer (5s.)	1 9 0	1 3 3
New State Areas (15s. 6d.)	6	6
President Brand (5s.)	2 11 3	2 7 6
President Steyn (5s.)	16 0	13 9
Rand Leases (9s. 3d.)	4 9	3 6
Randfontein	18 9	15 9
Rietfontein (3d.)	3 0	2 6
Robinson Deep (3d.)	4 9	4 0
Rose Deep (3d.)	5 9	5 6
St. Helena (10s.)	3 0 0	2 14 9
Simmer and Jack (1s. 6d.)	1 0	9
South African Land (3s. 6d.)	13 3	12 3
Springs (3d.)	1 3	1 0
Stilfontein (5s.)	1 9 6	1 6 9
Sub Nigel (3d.)	8 6	6 9
Vaal Reefs (5s.)	1 19 0	1 17 6
Van Dyk (3d.)	2 3	1 6
Venterspost (10s.)	19 0	16 0
Virginia (5s.)	3 0	2 6
Vlakfontein (10s.)	16 3	14 3
Vogelstruisbult (3d.)	4 3	3 3
Welkom (5s.)	13 6	10 9
West Driefontein (10s.)	4 2 6	3 13 9
West Rand Consolidated (10s.)	16 9	14 6
West Witwatersrand Areas (2s. 6d.)	2 11 9	2 7 3
Western Holdings (5s.)	6 0 0	5 9 0
Western Reefs (5s.)	1 5 0	1 2 3
Winkelhaak (10s.)	1 1 9	19 3
Witwatersrand Nigel (2s. 6d.)	9	6
Zandpan (10s.)	10 0	7 6
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	13 9	12 6
Coronation (2s. 6d.)	4 0	3 6
Falcon (5s.)	7 6	7 0
Globe and Phœnix (5s.)	1 7 6	1 7 6
Motapa (5s.)	—	—
GHANA:		
Amalgamated Banket (3s.)	—	—
Ariston Gold (3s. 6d.)	—	—
Ashanti Goldfields (4s.)	12 6	13 0
Bibiani (4s.)	—	—
Bremang Gold Dredging (5s.)	—	—
Ghana Main Reef (5s.)	—	—
Konongo (2s.)	1 0	1 0
Kwahu (2s.)	4 6	4 6
Offin River (2s. 6d.)	2 0	1 9
Western Selection (5s.)	4 9	4 3
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 3	1 6
Gold Mines of Kalgoorlie (10s.)	8 0	8 9
Great Boulder Propriet'y (2s.), W.A.	11 6	11 6
Lake View and Star (4s.), W.A.	1 3 9	1 4 3
Mount Morgan (10s.), Q.	11 6	11 6
New Guinea Gold (4s. 3d.)	1 3	1 3
North Kalgurli (1912) (2s.), W.A.	9 3	9 6
Sons of Gwalia (10s.), W.A.	3 0	3 0
Western Mining (5s.), W.A.	13 3	16 9

	June 8, 1961 £ s. d.	July 10, 1961 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 15 0	1 15 0
Kentan Gold Areas	18 3	17 6
St. John d'el Rey, Brazil	4 16 3	4 17 6
Yukon Consolidated ($1)	3 9	3 3
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	13 6	12 3
Esperanza (2s. 6d.), Cyprus	1 4	1 3
Indian (2s.)	5 9	6 0
MTD (Mangula) (5s.)	6 9	6 9
Messina (5s.), Transvaal	14 0	11 6
Mount Lyell (5s.), Tasmania	6 6	6 3
Nchanga Consolidated, N. Rhodesia	2 9 0	2 3 3
Rhokana Corporation, N. Rhodesia	2 7 0	2 1 6
Roan Antelope (5s.), N. Rhodesia	5 6	5 3
Tanganyika Concessions (10s.)	1 3 6	1 2 3
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	9 6	11 0
Burma Mines (3s. 6d.)	1 3	1 0
Consol. Zinc Corp. Ord.	3 12 6	3 7 0
Lake George (5s.), N.S.W.	3 6	3 0
Mount Isa, Queensland (5s. Aust.)	2 13 6	2 12 6
New Broken Hill (5s.), N.S.W.	2 10 0	2 11 3
North Broken Hill (10s.), N.S.W.	16 3	16 9
Rhodesia Broken Hill (5s.)	6 9	6 3
San Francisco (10s.), Mexico	14 3	19 3
TIN:		
Amalgamated Tin (5s.), Nigeria	12 6	12 3
Ampat (4s.), Malaya	19 0	17 0
Ayer Hitam (5s.), Malaya	2 6 3	2 19 0
Beralt (5s.), Portugal	1 11 3	1 7 9
Bisichi (2s. 6d.), Nigeria	5 6	5 3
Ex-Lands (2s.), Nigeria	3 9	4 0
Geevor (5s.), Cornwall	1 3 0	1 4 0
Gold Base Metals (2s. 6d.), Nigeria	2 0	1 9
Hongkong (5s.), Malaya	1 4 0	1 7 0
Jantar Nigeria (3s.)	5 9	5 9
Kaduna Syndicate (2s.), Nigeria	2 9	2 9
Kamunting (5s.), Malaya	1 0 0	1 1 6
Malayan Tin Dredging (5s.)	1 13 0	2 7 0
Mawchi Mines (4s.), Burma	1 3	1 6
Naraguta Karama (5s.), Nigeria	1 3	9
Pahang (5s.), Malaya	17 9	19 6
Siamese Synd. (5s.)	18 3	1 2 6
South Crofty (5s.), Cornwall	3 9	4 9
Southern Kinta (5s.), Malaya	1 14 0	2 10 0
Southern Malayan (5s.)	1 13 6	1 16 9
Sungei Besi (4s.), Malaya	2 3 6	2 19 6
Sungei Kinta, Malaya	19 3	16 0
Sungei Way (2s. 4d.), Malaya	4 9	5 6
Temoh (7s. 6d.), Malaya	4 9	5 3
Tronoh (5s.), Malaya	3 3 6	4 7 6
United Tin Areas (2s. 6d.), Nigeria	2 0	2 0
DIAMONDS:		
Anglo American Investment	11 5 0	10 15 0
Consol African Selection Trust (5s.)	15 0	14 9
Consolidated of S.W.A. Pref. (10s.)	9 0	7 6
De Beers Deferred (5s.)	6 12 3	6 1 3
FINANCE, ETC.		
African & European (10s.)	2 14 9	2 10 0
Anglo. American Corporation (10s.)	6 10 0	5 11 6
Anglo Transvaal 'A' (5s.)	1 8 3	1 6 6
British South Africa (15s.)	3 1 9	3 1 6
British Tin Investment (10s.)	2 3 0	2 4 0
Broken Hill Proprietary	3 2 6	2 15 9
Camp Bird (10s.)	6 3	5 0
Central Mining	1 12 3	1 11 6
Central Provinces Manganese (10s.)	18 0	14 6
Consolidated Gold Fields	2 11 6	2 4 3
Consolidated Mines Selection (10s.)	1 5 9	1 3 3
Corner House	11 3	8 9
East Rand Consolidated (5s.)	2 0	1 6
Free State Development (5s.)	3 3	3 3
General Exploration O.F.S. (2s. 6d.)	3 3	2 6
General Mining and Finance	4 7 6	3 15 0
Hendersons (4s.)	8 0	6 6
Johannesburg Consolidated	2 1 9	1 16 9
London & Rhod. M. & L. (5s.)	5 0	6 6
London Tin Corporation (4s.)	17 3	1 0 3
Lydenburg Est. (5s.)	9 3	5 6
Marsman Investments (10s.)	2 7½	2 7½
National Mining	2 0	1 9
Rand Mines (5s.)	3 7 3	2 15 0
Rand Selection (5s.)	2 1 3	1 13 0
Rhodesian Anglo American (10s.)	2 19 3	2 12 0
Rhodesian Corporation (5s.)	1 9	1 9
Rhodesian Selection Trust (5s.)	10 0	9 3
Rio Tinto (10s.)	1 18 9	1 15 6
Selection Trust (10s.)	4 13 0	4 6 0
South West Africa Co. (3s. 4d.)	11 3	12 6
Union Corporation (2s. 6d.)	2 10 9	2 3 3
Vereeniging	4 8 0	3 15 0
West Rand Inv. Trust (10s.)	2 3 6	1 18 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Handling Anode Slime

A paper by S.S. Forbes on "Handling of Anode Slime at Canadian Copper Refiners, Ltd." is one of a series in the *Canadian Metallurgical and Mining Bulletin* for May dealing with handling acid slimes. Mr. Forbes says that electrolytic refining of impure copper anodes of about 99% copper content produces copper cathodes of 99·97% purity and an anode slime which is treated for the recovery of various elements. The composition of the slime varies, but, generally, it contains copper, silver, gold, selenium, tellurium, antimony, arsenic, silica and lead. The removal and recovery of copper, silver, gold, selenium, and tellurium from the slime is economic. It is to this end that an extensive system of acid slurry handling of slime is carried out.

Throughout the electrolysis an anode slime is formed which sloughs off the anode surface and accumulates in the bottom of the cells. At the end of each anode cycle (about 26 days) the cathodes and the balance of the undissolved anodes are withdrawn. The anode slime and electrolyte is then transferred from the electrolytic cells to a slime pit, from which the slurry is pumped to the silver refinery. The electrolytic cells are lined with lead which lasts for about 20 years before replacement is necessary. Leaks in the lead lining caused by falling anode scrap are easily repaired by burning in new lead.

The treatment of the anode slime slurry in the silver refinery is designed to recover copper, silver, gold, selenium, and tellurium. Anode slime pumped from the tank house is received in a lead-lined surge tank in the silver refinery. Overflow from the surge tank is returned to the tank house. The slime is pumped from the surge tank to the first of two thickeners arranged in series. The overflow from the first thickener flows to the second, while the overflow from the second returns to the tank house. The thickeners are built of type 316 stainless steel. To reduce maintenance stainless steel has been used in recent years to replace much of the former lead-lined equipment.

From the thickeners the slime-acid slurry is dropped to a make-up tank for adjustment with electrolyte to 25% solids by weight. Once adjusted the batch is transferred to a holding tank from which it is pumped to a horizontal continuous centrifuge. The purpose of the centrifuge is to lower the moisture content of the slime to 20% prior to treatment in the acid digestion and roasting stages.

The centrifuge is subjected to both corrosion and abrasion. Initially corrosion of the centrifuge bowl was marked, but after the installation of an ELC type 316 stainless-steel bowl this has been slight. However, the screw conveyor, which rotates 80 r.p.m. slower than the bowl, is regularly replaced after about 1,000 hours of operation. At that time the flights of the conveyor are so worn that the centrifuge fails to clear itself. Spare conveyor flights are provided. The worn conveyor flights are rebuilt with type 316 stainless steel. A hard facing is welded to the leading extremities of the conveyor blades.

After centrifuging the slime is charged to acid digestors, in which concentrated 66° Bé. sulphuric acid converts copper compounds in the slime to copper sulphate and frees selenium and tellurium which have been combined with either copper or silver. Acid digestion is carried out in mild-steel pans at a temperature of approximately 500° F. External heat is supplied by utilizing the combustion gases from the roasting furnace with which the digesters are associated as well as auxiliary heat burning vapourized stove oil.

Corrosion and abrasion of digester bottoms is severe, with bottoms lasting for only three or four weeks. During the initial stages of digestion moisture in the centrifuged slime dilutes the sulphuric acid to about 80%, a corrosive concentration for mild steel. As the water in the digester evaporates the heat and abrasion further reduce the life of the digester pans. No satisfactory economic material has been found to resist the combined attack of corrosion,

abrasion, and heat. Digester bottoms are replaced when corroded.

After digestion is complete in 8 to 12 hours the slime is dropped to a mild-steel screw conveyor for feed to the roasting furnace. Although hot the acid slime mix does not corrode the conveyor system severely and the life of these conveyors is about two years.

To volatilize selenium, which is recovered in a scrubber-Cottrell, the digested slime is roasted at about 1,300° F. on a pan conveyor around which a furnace is built. This furnace is cast in sections using an aggregate of crushed firebrick and high alumina cement. The life of a furnace is approximately five years. The furnace is heated by burning vapourized stove oil in manifolds which keep the products of combustion separate from fumes evolved by the roasting process. Manifolds, made of mild steel, last about 12 weeks. Trials with type 316 and 442 stainless steel showed no advantage in favour of these expensive alloys. The digested slime is conveyed through the roasting furnace on overlapping mild-steel plates. These plates last about one year.

The roasted slime is treated to separate and recover its content of copper, silver, gold, and tellurium. This is done by water-leaching the slime to remove copper as copper sulphate followed by leaching with caustic soda to remove tellurium as sodium tellurite.

The slime at this stage has most of the selenium, tellurium, and copper removed. To convert this material to a form in which it can be electrolyzed to separate silver and gold it is smelted and refined with chemicals in a small reverberatory-type furnace.

The refined metal is cast from the furnace as anodes of doré metal, an alloy of silver and gold. It is then processed through electrolytic cells which separate the silver and gold. Final products from this process are silver bullion and gold bullion of 999·9 fineness.

Australian Beach Sands

A section of an article by J. Woodcock on "Ore Dressing Developments in Australia, 1960," appearing in the *Mining and Chemical Engineering Review* for March 15 last deals with the beach-sand industry. Although this industry, the author says, is passing through a comparative lull in operations, there was a surprising amount of new plant construction as well as changes and consolidation in existing plants during the year under review. These developments appeared to be aimed mostly at improving efficiency and reducing costs. In addition the beach-sand industry is becoming more control conscious.

National Minerals Pty., Ltd., has had nine months' operating experience with its new dredge "Titian," which has generally realized expected results. Since operations began the dredge has travelled 1,300 yd. working a width of 80 yd. either parallel to the beach or at right-angles to it to intersect high dunes to the west. This was done to test the efficiency of the unit when treating grades between 0·5% and 7% heavy minerals and to test its capacity in low and high terrain. On several occasions a face exceeding 70 ft. was mined with a dragline.

Concentration is achieved by 312 rubber spirals of the company's own design which in one pass recover over 90% of the heavy minerals when treating 8 g.p.m. to 10 g.p.m. of pulp containing 35% to 55% solids, depending on grade. With low feed grades throughputs of 45,000 tons to 55,000 tons per week were obtained, together with minimum heavy-mineral recoveries of 92%. Concentrates contained 80% to 90% heavy mineral. Continuous sampling is conducted to check on all phases of operations and metallurgical reports are compiled for each shift.

Expected operating savings have been realized. One attendant is more than sufficient provided wash-water is pre-cleaned. Power consumption of 430 A at 415 V is less than expected. Maintenance of the pontoon tanks is very low. After 12 months' immersion they show no sign of corrosion and have required no repairs. There has been no major alteration to the design; tailing disposal was simplified to speed operations. An 8/6 suction pump was available and is used, in addition to the one in operation, to maintain throughput during moving of the dredge. Tailings are now disposed of by the two pumps which each handle 150 tons to 230 tons per hour, depending on the disposal distance and the grade of the feed. Down time of the dragline in moving operations now averages 3·5% of working time. The company intends to operate "Titian" at full capacity in 1961.

Zircon Rutile Pty., Ltd., early in 1960 reconstructed and enlarged one of its dredge plants in

the Byron Bay area. York concentrators were installed in place of spirals and have proved very satisfactory. The plant now consists of three floating units, a dredge, concentrator, and tailings unit.

The dredge unit, of steel construction, contains a 6-in. Thompson pump, a trommel screen, and a large surge bin. A 6/4 Warman pump transfers screened pulp containing 35% solids to the concentrating unit at a regular rate.

The concentrating unit is a covered wooden barge containing 20 primary and six secondary York concentrators with necessary feed pumps. Feed pulp to the York concentrators is accurately controlled to contain 60% solids and recording meters are used to check operations.

The tailings unit consists of four pontoons with a tower supporting an elevated adjustable tailings line. Residues are pumped out at a controlled high pulp density, thus assisting in rebuilding the dunes and reclaiming the area.

Titanium Minerals, Ltd., enlarged and modified its separation plant to produce both rutile and zircon instead of rutile only. In addition tailing dumps containing the zircon formerly rejected are being re-treated on a part-time basis. Besides zircon a little rutile is also recovered.

In the wet concentration section a bank of eight fibre-glass spirals manufactured by Mineral Deposits Pty., Ltd., was installed ahead of the four Scott tables. These spirals have a pitch of 15½ in. as compared with a pitch of 13½ in. on other makes of spirals. They effectively reject silica and " light heavies," but loss of economic minerals is low. In addition a Curvilinear table formerly used for testing and pilot-scale work was installed. It treats the combined middlings from the four Scott tables and makes a concentrate which is added to the main table concentrate and a tailing which is run to waste. By using the middlings table the silica content of the concentrate delivered to the dryer is reduced to less than 0·1% and the content of " light heavies " is also reduced.

After drying the concentrate is fed to a 2-roll high-tension rougher which is followed by two stages of rutile cleaning and three stages of zircon cleaning. The final conducting and non-conducting products are each passed over a duplex 3-roll magnetic separator to produce final rutile and zircon. In re-treating tailings a screen is used to reject coarse zircon.

N.S.W. Rutile Mining Co. Pty., Ltd., took advantage of the lull in the market to effect major alterations and improvements to its treatment plant, buildings, and flow-sheets. The company purchased the complete wet and dry plants of Australasian Oil Exploration, Ltd. (A.O.E., Ltd.) at Mermaid Beach, Queensland, and is incorporating this equipment in its existing plant, thus greatly enlarging its production potential. Changes are not yet complete.

Operation of spiral plants was curtailed in recent years because of the depressed market, but it is apparent that to mine profitably material containing 0·5% to 3% heavy mineral large volumes must be handled. With this in view two new large spiral plants fed by 10-in. Thompson pumps are planned to operate in 1961.

In 1960 a land-based spiral plant fed by an 8/6 Warman suction pump on a floating dredge working south was operated experimentally at Kingscliff. Humphreys cast-iron spirals are used and the plant comprises 108 primary, 36 secondary, 14 tertiary, and 36 scavenger spirals, middlings being taken at any stage. Recording ammeters and density meters are installed at key points.

The table concentration flow-sheet was modified by using one table for middlings re-treatment in place of Humphreys spirals. This flow-sheet is being further modified and its potential capacity has been amplified by the acquisition of nine new Scott tables from A.O.E., Ltd., in addition to the eight Wilfley tables already in operation. Research is in progress to remove fine quartz from table feed.

In the dry mill at Cudgen, N.S.W., a new flow-sheet is being designed using local and overseas knowledge and experience. Full details are unavailable but the new circuit will include Carpco equipment obtained from A.O.E., Ltd., and electromagnetic separation will be conducted on relatively-cool material. A No. 21 single-stage Lockers Rotex screen will be used to screen out quartz and leucoxene. Geary-Jennings automatic samplers will be installed at key points for close metallurgical control.

A large store has been constructed to hold bagged product awaiting shipment. Bags are palletized and handled by fork-lift trucks. For sealing the bags 3-M tape made by Minnesota Mining and Manufacturing (Aust.) Pty., Ltd., is being tried. A well-equipped modern laboratory has been set up. The function of this laboratory is to keep a close control on the quality of final products and to ensure efficiency and economy in all intermediate processes. It will also assist in prospecting and proving new areas.

The Titanium Alloy Manufacturing Co., Ltd., remodelled its Fanning concentrating plant to include a final stage of scavenging using 80 concrete 24 in. diameter spirals on an existing second barge. This change enabled plant throughput to be increased from 45 tons to

70 tons per hour, while recovery of rutile and zircon was increased from 85% to over 95%.

T.A.M. Co. also instituted a pre-tabling procedure before dry concentration. This was done because an increase in salinity of the water in the wet concentration plant pond led to the rutile concentrate from direct dry separation being hygroscopic and unacceptable to most buyers. Hence pre-tabling is conducted with the primary objective of using the limited amount of fresh water available as a wash at the concentrate end of the tables. A secondary objective is to remove as much quartz and " light heavies " as possible with low loss of zircon and rutile. By reducing the concentrate to 80% of its original weight the saving in drying costs helps to offset the added cost of pre-tabling.

The flow-sheet remained unchanged; tabling of pinned product from rutile high-tension separation was continued. High-tension separation of de-salted concentrate was much easier and less susceptible to the influence of atmospheric change. Pre-tabling and dry separation were practised on alternate weeks.

Associated Minerals Consolidated, Ltd., made changes in its tabling circuit that improved mineral separation and reduced water consumption.

Westralian Oil, Ltd., continues to operate for the production of ilmenite. Control of moisture content and of temperature at certain stages is very important and the plant has been modified accordingly. Occluded water in the flash drier product fed to the high-tension separators caused a build-up on the rolls and adversely affected separation. However, when the hot mineral is exposed to the atmosphere for a short time this water is released without great loss of temperature and a much more efficient separation of the conducting fraction can be obtained.

For efficient magnetic separation the temperature of the conductors from high-tension separation is reduced nearly to ambient temperature in a cylindrical type-cooler equipped with a fan before feeding to the belt-type magnetic separators.

For best results in the leucoxene recovery section of the plant it is necessary to raise the mineral temperature to about 70° C. in reheat units before feeding it to the separators. No substantial sales have yet been made of the leucoxene product but it is being tested for various uses.

The Titanium Alloy Manufacturing Co. Pty., Ltd., added several 24 in. diameter fibre-glass spirals with a pitch of 15½ in. to its tabling section. These spirals operate in parallel with Wilfley tables and give comparable results.

Associated Minerals Consolidated, Ltd., installed a 6 ft. by 60 in. Hardinge conical pebble mill together with a Hardinge Superfine classifier and dust collection system. This mill is operating at design capacity and shipments of ground silica, rutile, and zircon have been made.

In addition Associated Minerals has received a Kipp Kelly air float separator that will be installed in the zircon section during 1961 to give a very high-grade zircon product for ceramic use.

Western Titanium N.L. incorporated in its circuit a dry launder concentrator for monazite upgrading, and a similar unit for scalping coarse sand from primary ilmenite tails.

N.S.W. Rutile Mining Co. Pty., Ltd., has incorporated a No. 21 single-stage Lockers Rotex screen in its new dry mill to screen out quartz and leucoxene.

The Titanium Alloy Manufacturing Co. Pty., Ltd., noted that coarser minerals of low susceptibility accumulated in the circulating load in its rutile-ilmenite magnetic circuit. Hence a locally-made 50-mesh vibrating screen was installed to treat the " non-magnetic " fraction from the secondary Carpco magnets. Screen undersize is returned to the primary magnets, while the oversize, carrying a negligible amount of rutile, is discarded.

Titanium Minerals, Ltd., found when retreating tailings that a build-up of coarse zircon occurred in the conductor reject being returned to the high-tension rougher from the zircon finishing side because it could not be successfully pinned. This material entered the rutile finishing side and reported in the final rutile product. To overcome this difficulty a 60-mesh shaking screen was installed over the high-tension roughers to treat material being returned from the zircon side. Screen undersize is returned to the rougher while the oversize is discarded and no further trouble has been experienced.

In part the trouble was caused because in the tailing treatment circuit the ratio zircon : rutile is roughly 7 : 1, and so the presence of a small proportion of coarse zircon has a marked effect on rutile product quality. It seems that this trouble is less likely to occur when treating normal concentrates in which zircon and rutile are present in more nearly equal proportions.

Titanium and Zirconium Industries Pty., Ltd., conducted tests with a D.S.M. screen as a possible pre-concentrator.

Associated Minerals Consolidated, Ltd., obtained economies by the use of heavy fuel and introduction of a new exhaust and duct collection system in its drying section.

Titanium and Zirconium Industries Pty., Ltd., replaced a plate electrostatic unit in its zircon section with a high-tension roll separator to maintain zircon quality.

Western Titanium N.L. replaced two high-tension roll separators with screen-plate electrostatic separators and obtained improved separation in its secondary plant. The plant has operated continuously throughout the year producing rutile, zircon, monazite, and leucoxene.

Coffs Harbour Rutile N.L. follows normal practice in a conventional circuit. Sand is currently mined in high dunes about $\frac{3}{4}$ mile from the sea by dredging with a suction cutter above a puggy clay band. The dredge pond is kept above sea-level. Dredged sand is pumped to a land-based spiral plant equipped with 80 primary and 20 secondary spirals. Tailings from this plant are pumped away for stacking while the concentrate is trucked a mile to the separation plant. After tabling the spiral concentrate to remove silica the heavy-mineral concentrate is dewatered on a vacuum cone and then dried in a rotary oil-fired furnace. Hot dry mineral from the furnace is electrostatically separated on rolls and plates to give two products. These products are treated on magnetic separators to yield finished rutile and zircon as well as two magnetic tailings.

Western Titanium N.L. made no changes in its ilmenite recovery circuit and again regulated the production of ilmenite in accordance with demand.

Titanium and Zirconium Industries Pty., Ltd., made no major changes in circuit or capacity but obtained slightly better results because of improved operating efficiency. Instrumentation for the dredges is being investigated.

Crescent Rutile N.L. and Cudgen R.Z. had no new developments to report.

Determination of Cut-Off Grade

An article by E. L. VICKERS in *Mining Engineering* for June treats of "Marginal Analysis : Its Application in Determining Cut-off Grade". The cut-off grade the author defines as the point below which a mineral resource ceases to be economically amenable to extraction. The cut-off grade, he says, can be a very elusive line of demarcation, but, properly applied the technique of marginal analysis can tell at what point to stop extracting low-grade mineralized rock. It demonstrates the amount of rock which can be extracted from an orebody. That point of cut-off is defined in this analysis as the point which maximizes total profits for the orebody, given a specific cost-revenue situation. What marginal analysis does, quite simply, the author says, it to bring into focus the impact on that relationship between cost and revenue when the level of activity is varied. In this analysis the level of activity which must be varied is merely the reserve factor.

In dealing with a marginal concept lower and lower grade ore is added until total profits cease to increase. Each unit of material which is added to the higher-grade ore, when mined, produces increasingly higher cost per pound. At some point the up-scaling of additional costs must assuredly outweigh the benefits received from the larger tonnages of the lower-grade ore. Hence, the solution of such a problem refers itself immediately to one of classical marginal analysis.

Before proceeding further it is advisable to make a few basic definitions :—

Average Revenue Per Pound of Metal.—Average revenue is the total price received for a product divided by the number of pounds sold.

Average Total Cost Per Pound of Metal.—Average total cost is the total operating cost—*i.e.*, variable cost *plus* fixed cost incurred in producing a product, divided by the total number of pounds produced.

Variable Cost.—Variable cost is that total cost incurred in producing a product which tends to vary with the level of output, divided by the total units produced.

Fixed Cost.—Fixed costs are total costs for that outlay of factors which do not vary with the level of output, remaining the same regardless of the level of recovery.

Marginal Revenue.—Marginal revenue is the additional revenue obtained when one additional unit is sold. If the total output increases by one unit the resulting change in total revenue is marginal revenue.

Marginal Cost.—Marginal cost is the total additional cost that is incurred by the production of one additional unit.

Level of Recovery.—Level of recovery is the total number of pounds of metal actually

extracted from a given body of ore ; thus it is a function of the grade.

Rate of Recovery.—Rate of recovery is the annual production rate of the mining operation expressed in tons.

The analysis then proceeds in the following sequence : First, the framework on which marginal analysis is built is reviewed ; secondly, this framework is modified to fit the solution of the problem, and, finally, a hypothetical situation is envisaged. Necessary variables are isolated and fitted into the theoretical framework. The solution of the problem will then follow out of this logical structuring of variables.

Before an analysis can be carried out, the author says, certain basic assumptions upon which the analysis will be based must first be understood. The first is that the firm's objective is to maximize the total possible profits available from the orebody. More precisely, the firm will produce the average grade of ore which provides the largest margin between total revenue and total cost. The determination of the lowest grade that can be extracted at which total profits are maximized is thus the cut-off grade. In addition, it is assumed that the price of the product is a constant, known by the firm. This price is uninfluenced by the company's own sales and, further, this firm can sell at that price any amount it produces.

The first issue is to define the position of the marginal revenue and average cost per pound line. Under the condition of pure competition (also assumed for the sake of control) these two elements coincide and follow a horizontal line at the given price level per unit.

Average costs classically will follow a pattern. At very low levels of recovery they fall rapidly due to the absorption of the fixed-cost element in increasingly larger numbers of units of output. At a certain output level this curve will reach a minimum, then it reverses and swings upward. Graphically this reflects the point of diminishing returns and the addition of more units of output results in higher overall costs per unit. The lowest point of this curve defines the maximum value of one unit of output ; however, this is *not* the optimum level of operation. Maximum total profits from the orebody defines a firm's optimum level of recovery.

Marginal costs will first cross the average cost curve at the latter's minimum point. Then the marginal cost curve continues to rise at increasingly higher levels of output until it ultimately crosses the marginal revenue curve. The relationship between average costs and marginal costs is not mere coincidence. They show a general mathematical relationship wherever there is a decreasing, then increasing, relationship between two variables. In the marginal analysis model it is invariably true that : First, the average cost curve falls so long as the marginal curve is below it ; secondly, that the average cost curve rises and continues to rise so long as the marginal curve is above it, and, thirdly, that the marginal curve, therefore, intersects the average curve at the precise point where the latter is horizontal—that is, where the average cost per pound is a minimum. The firm's equilibrium position of maximum profits is found at the level of output where marginal cost and marginal revenue are equal. At lower outputs the increment in revenue is greater than the increment in cost as output is increased by one unit, but at higher outputs the marginal cost exceeds the marginal revenue with a consequent reduction in total profits.

To define cut-off grade the analysis requires one additional assumption—namely, the rate of recovery (tons produced per annum) will be held constant for all possible levels of recovery. Although there is a definite inter-relationship between the two, it will be assumed that rate of recovery is a predetermined factor and only the level of recovery (or grade produced) need be varied.

In a plot the marginal and average revenue line represents the sales price of the metal and is a horizontal line for any amount of metal produced. The abscissa measures the average and marginal cost per pound of metal produced ; the ordinate cost per pound of metal produced. The ordinate depicts the reserves of a hypothetical orebody. As reserves are increased the grade logically is decreased and therefore the amount of recoverable metal climbs, but the rate at which it increases is defined by the grade distribution in the orebody.

Average total costs per pound of metal decrease to a point, level off, and then increase. Average total costs are, of course, a function of tons mined. As the reserves are increased by the lowering of the grade the amount of contained pounds of metal per ton of ore mined decreases ; consequently there is an increase in the total cost per unit. Marginal costs will behave in a similar manner, but they will rise at a different rate. The incremental addition of lower-grade ore produces less and less revenue per ton and at the same time incremental costs continue to rise. A point of equilibrium between marginal revenue and marginal cost finally occurs. The additional pounds of ore now fail to provide additional net revenue and the level of optimum recovery is reached. Thus the cut-off point is defined.

Trade Paragraphs

Rapid Magnetic, Ltd., of Lombard Street, Birmingham, have issued a fully descriptive leaflet on their Andox permanent magnetic pulleys for tramp iron removal which were the subject of a preliminary notice in the June issue.

Richard Sutcliffe, Ltd., of Horbury, Wakefield, Yorks., in a recent illustrated folder describe their stable hole conveyor suitable for 50 t.p.h. of coal or stone at a belt speed of 140 ft./min. with electric drive and p.v.c. 3-ply Tugron duck belt.

Steel and Co., Ltd., of Sunderland, with its associated companies have moved from their various London offices to be housed under one roof at Steel House, Eastcote, Pinner, Middx. An important factor which influenced the location of Steel House is the proximity of Eastcote to London Airport. Among the group companies affected is **F. Taylor and Sons (Manchester), Ltd.,** manufacturers of mining plant.

Allis-Chalmers Manufacturing Co., of Milwaukee, Wisconsin, describe the features of 22-in. and 30-in. Hydrocone crushers with Hydroset control in a new bulletin recently issued. Designed with a range of chambers for coarse, intermediate, or fine crushing, the units are available with feed openings to 5 in. and capacities up to 68 t.p.h. The bulletin contains cutaway diagrams of the crusher and its instant hydraulic adjustment, dimensions, and approximate capacities.

Head, Wrightson, and Co., Ltd., of 20, Buckingham Gate, London, S.W. 1, point out in a recent notice, and with reference to an illustrated leaflet, that Head, Wrightson Processes, Ltd., have been actively concerned with the problems of cooling and heating process fluids for many years and their recent expansion in the water and effluent treatment field now enables them to offer a comprehensive service to all process plant users for improved efficiency.

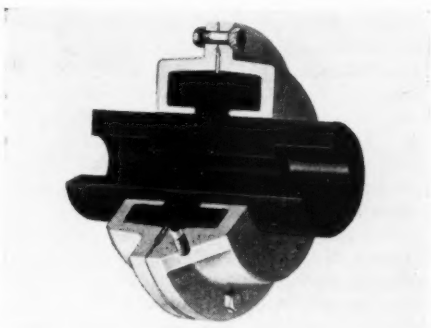
Hackbridge and Hewittic Electric Co., Ltd., of Walton-on-Thames, Surrey, recently issued a new publication on large transformers both naturally and artificially cooled. The booklet, which is well illustrated, describes the cooling arrangements, the core, the windings, the tappings, drying out, the banks, terminal arrangements, and auxiliary circuits. Another booklet deals with silica and germanium rectifiers and discusses their applications and which type to use.

International Combustion (Export), Ltd., of 19, Woburn Place, London, W.C. 1, have produced a 10-page illustrated publication on Hardinge thickeners. After describing the construction this goes on to give details of the auto-raise device which automatically lifts the sludge-removal mechanism if there is an overload or obstruction on the bottom of the bank. Tray thickeners are also described and there are sections devoted to the washing out of soluble salts by decantation, to thickening before filtration or centrifuging, and to flocculation.

W. H. Rowe and Son, Ltd., of Quayside Road, Bitterne Manor, Southampton, announce the addition of a new 6-in. diameter pinch valve to their range. Operation is by hand, lever, air cylinder, or diaphragm motor, but initially the new valve will be hand-operated only. The company also announce the introduction of Butyl sleeves for use with their pinch valves, which will extend their use in the chemical field. A wide range of standard sleeves are available to suit alcohol, acids, gases, petroleum, and abrasive materials.

British Mining Tools Association, of Light Trades House, Melbourne Avenue, Sheffield, announce that the Association was recently formed of 33 firms (original members) engaged in the manufacture of tungsten carbide mining tools, tips for mining tools, or of raw materials or blanks used in their manufacture. The purpose is to enable manufacturers to co-operate with each other on common technical problems concerning specifications as well as with other organizations and technical bodies in the interests of the industry as a whole.

Neldco Processes, Ltd., of Crossway House, Bracknell, Berks., recently announced that a modified design of the Sala round aperture



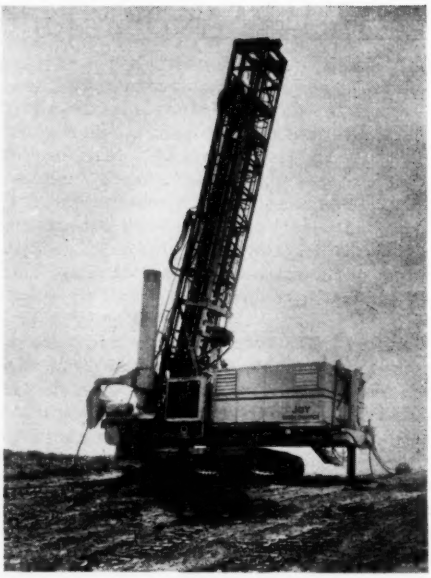
valve is now available in small sizes (as illustrated). The outer casing is of cast aluminium and closure is effected by hydraulic or pneumatic pressure on the rubber muscle as in the standard valve. The inner liner of neoprene is, however,

extended and recessed to fit over a standard steel pipe and to be secured with hose clips. This type is now produced with 1-in. ½-in., and ¼-in. bores and intermediate sizes can be supplied to order. The aperture remains completely round from full bore to closure and the valves are particularly suitable for the control of slimes.

Goodyear Tyre and Rubber Co. (G.B.), Ltd., of Wolverhampton, make available some notes on their newly introduced " Green Seal " range of V belts, which apart from having a longer working life than the previous type *plus* greater efficiency, enable fewer belts and lighter pulleys to be used on the same job. The two new belts available are the E.C. Red V-Belt, with a 40% higher horse-power rating than the old standard E.C. V-belts at same cost, and the HY-T Premium V-Belt, having a 100% higher horse-power rating than the old E.C. V-Belt—at only 25% extra cost. The latter belt is static conducting and oil-resistant, while both are dimensionally stable under all shocking conditions.

Associated Electrical Industries, Ltd., of Crown House, Aldwych, London, W.C. 2, announce that rectifier equipment for extensions to the aluminium smelting plant of A/S Ardal og Sunndal Verk, Norway, is in its final stages of manufacture in their Rugby works. Most of the equipment has been dispatched and erection at site started early in March. The equipment is rated 108,000 kW and the new extensions represent an increase in production capacity of 32,000 tons per year. The semiconductor rectifier equipment now being completed at Rugby is rated at 135,000 amp., 800 volts, d.c. AEI germanium rectifiers were selected on the technical merits of the equipment and on the successful operating experience already obtained in service.

Joy-Sullivan, Ltd., of 7, Harley Street, London, W. 1, make available some information on the Joy G56-BH Champion drill put out by their associates Joy Manufacturing Co., of Pittsburg. The machine is an electrically-driven (diesel optional) rotary blast-hole drill using the air-blast method of removing cuttings from the hole. An overhead drive unit rotates the drill pipe through a hydraulic motor and a four-speed hydraulically-actuated transmission. Down-pressure of up to 65,000 lb. is also hydraulically powered. The derrick tilts to 30° from vertical for angle-face drilling. Compressed air is delivered from a sliding-vane rotary compressor available in several sizes. The machinery deck rotates in a 360° circle to permit drilling at the end or over the side of the crawlers. All drilling functions are controlled



from a single control point for one-man operation.

Two double-acting hydraulic cylinders tilt the derrick for drilling at any angle from vertical to 30° off vertical in the standard drill, which means that it is capable of angle-face drilling with a minimum of set-up time. This relatively new technique in strip and open-pit mines is reported to result in lower-cost blasting, better fragmentation, and more stable banks. Positioning the derrick at any angle from vertical to 30° off vertical is fast and simple being controlled from the operator's cab. The two hydraulic cylinders are equipped with safety checks to ensure against slippage of the derrick from its desired position.

Johnson, Matthey and Co., Ltd., of 73–83, Hatton Garden, London, E.C. 1, announce that they are now able to supply scandium, yttrium, and most of the 14 rare earth metals in sheet form in thicknesses down to 0·001 in. and with a maximum width of 3 in. The sheet is available either cold worked or annealed. This is the latest development in the company's production of the metals of this group, which have previously been available as ingots and in some cases as wire of diameters down to 0·02 in. A later announcement states that on June 15 the London Gold Market added the name Johnson, Matthey, and Mallory, Ltd., to the list of accepted melters and assayers and stated that bars produced by this company and bearing its stamp should be accepted as good delivery in London.

International Construction Equipment Exhibition

A preliminary review of this exhibition, based on advance information appeared in the June issue. In the following notes attention is called to some items seen there. As a whole it may be remarked that the exhibition was an impressive display of a variety of machinery used in engineering construction, road making, and building, much of which was being demonstrated under operating conditions.

Armstrong Whitworth (Metal Industries), Ltd., of Close Works, Gateshead-on-Tyne, showed a Kue-Ken 80 jaw-crusher and an A.W./Overstrom 4 ft. by 8 ft. single-deck vibrating screen. The crusher has a feed opening of 36 in. by 10 in. and is one of a range of 24 from 12 in. by $2\frac{3}{4}$ in. to 48 in. by 42 in. The vibrating screens are made in single-, double-, and triple-deck versions in sizes ranging from 3 ft. by 6 ft. to 5 ft. by 12 ft. Features of this equipment include the use of large spiral springs for transmitting vibratory motion to the screen box without loss of power.

Atlas Copco (Great Britain), Ltd., of Marylands Avenue, Hemel Hempstead, Herts., were showing for the first time their Tracrig, as illustrated, which consists of one of their

standard rock-drills mounted on a crawler chassis. The two track laying motors are each of 6 h.p. and air driven and hydraulic positioning of the booms enables this self-propelled unit to be used for parallel hole spotting from the vertical to the horizontal.

J. I. Case Co., Ltd., of West Drayton, Middx., included in their exhibit of earthmoving machinery an example of the 1000 mining special model which was described and illustrated in the MAGAZINE for December last. The machine is of 100 h.p. and has a break-out force of 18,600 lb. Its overall height in the standard version is 6 ft. 7 in. and in the low-clearance type 6 ft.

Chaseside Engineering Co., Ltd., of Hertford, Herts, included in their exhibit examples of both two-wheel drive and four-wheel drive loading shovels, the latter being represented by the 3000 Loadmaster of 150 h.p. and the 1000 machine.

George Cohen, Sons and Co., Ltd., of Wood Lane, London, W 12, were demonstrating for the first time the Northfield F7 dump truck in addition to Jones mobile cranes and Hiab loaders. The dump truck has a nominal $7\frac{1}{2}$ cu. yd. capacity and a 25,000 lb. pay load and is suitable for rock carrying, open-cast work, and mine spoil removal, having articulated power steering, a turning circle less than the length of the machine, good weight distribution, horizontal body pivoting, and a clutchless drive. Maximum speed on the level is 28 m.p.h. Power is provided by a Ford 6D engine, developing 96 b.h.p. at 2,250 r.p.m. driving through a Brockhouse torque converter. The machine is manufactured by **Northfield Industrial Fabrications, Ltd.**

Consolidated Pneumatic Tool Co., Ltd., of 232, Dawes Road, London, S.W. 6, were well represented by a display covering a wide range of equipment. Drills shown, for example, ranged from a $7\frac{1}{2}$-lb. rock-drill to a truck-mounted Reichdrill for 6-in. diameter holes. Seven different units of Power Vane air-compressors were shown ranging from 125 c.f.m. to 600 c.f.m. capacity. A CP-55 diamond drill was also included complete with core barrel.

Holman Bros., Ltd., of Camborne, Cornwall, introduced the Rotair 150 van-mounted rotary screw-type air-compressor, in addition to a range of rock-drills, other types of compressors such as the Tractair, drill rigs, sludge pumps, air engines, and hoists, Goodyear pumps, dust control equipment, and called attention to the pneumatic control equipment made by Maxam Power, Ltd.

Merton Engineering Co., Ltd., of Faggs Road, Feltham, Middx., were demonstrating a four-wheel-drive front loader equipped with a Deutz 4-cyclinder air-cooled engine. With power-assisted steering and semi-automatic hydraulic controls the machine has a crowd force of 10,000 lb.

Michigan (Great Britain), Ltd., of P.O. Box 3, Camberley, Surrey, were displaying a number of models from their range of earth-moving equipment both on the stand and in operation on the proving ground, particular attention being paid to those manufactured in this country. These include four models of the tractor shovel having bucket capacities of 1, $1\frac{1}{2}$, $1\frac{3}{4}$, and $2\frac{1}{2}$ cu. yd. respectively, all wheeled vehicles equipped with Perkins, Leyland, or Ford engines in power ranges from 62 b.h.p. to 109 b.h.p.

Shawnee Poole, Ltd., of Falcon House, Woodley, Reading, Berks., were showing a 5-cu. yd. model of their rear-dump hauler, which is a new addition to the range. The Shawnee-Poole system of earth-moving equipment was first described and illustrated in the MAGAZINE for December, 1958, the particular feature being the method of coupling the tractor to the rear-dump wagon by means of a goose-neck member which allows of a turning angle of 110° and articulation possible in all three planes.

F. Taylor and Sons (Manchester), Ltd., of Steel House, Eastcote, Middx., were demonstrating Taylor-Salem earth borers. These machines are particularly designed for excavation in connexion with the laying of cables or pipes for rapid advance. Two models are available : One with auger diameters of 6 in. to 16 in. and the other for 18 in. to 24 in. and both are hydraulically operated from a diesel engine running at 1,800 r.p.m. to 2,200 r.p.m. Other details are set out in an illustrated leaflet.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

The Mining Industry of Southern Rhodesia, 1961 : Cloth, quarto, 138 pages, illustrated. Published by the Seventh Commonwealth Mining and Metallurgical Congress, Southern Rhodesia Section : Salisbury, P.O. Box 2880.

Geology of the Country around Monmouth and Chepstow : Memoir of the Geological Survey of Great Britain. By F. B. A. WELCH and F. M. TROTTER. Cloth, 164 pages, illustrated. Price 22s. 6d. London : H.M. Stationery Office.

Échantillonage et Analyse des Minerais Hétérogènes à Faible Teneur : By A. PRIGOGINE. Paper covers, 180 pages, illustrated. Mem. Academie Roy. des Sciences d'Outre-Mer, Brussels. New Series, Vol. XV, Part. 1.

Analisi e Preparazione dei Minerai : Bibliografia Internazionale Scientifico-Tecnica. Paper covers, 140 pages. Rome : Comitato Nazionale pe l'Energia Nucleare.

The Miners in Crisis and War : A History of the Miners' Federation of Great Britain from 1930 onwards. By R. PAGE ARNOT. Cloth, octavo, 451 pages, illustrated. Price 42s. London : George Allen and Unwin, Ltd.

Bibliography of North American Geology, 1958 : United States Geological Survey Bulletin 1115. Paper covers, 592 pages. Price $2.00. Washington : Superintendent of Documents.

The Hydrology of the Murray Basin Province in South Australia : Geological Survey Bulletin No. 35. By E. P. D. O'DRISCOLL. Vol. 1, Paper boards, 148 pages, illustrated. Price 7s. 6d. Vol. 2, Appendixes and Maps. Price 5s. Adelaide : Department of Mines.

Sarawak : The Geology and Mineral Resources of the Lower Rajang Valley and Adjoining Areas. Geological Survey Memoir 11. By E. B. WOLFENDEN. Paper boards, 167 pages, illustrated, with map. Price 14s. Kuching, Sarawak : Geological Survey Department.

Year Book of the American Bureau of Metal Statistics : 40th Annual Issue, 1960. Paper covers, 139 pages. Price $4.00, postage 25 cents. New York : American Bureau of Metal Statistics.

The Vermiculite Handbook : Paper covers, quarto size, 39 pages, illustrated. London : Mandoval, Ltd.

Electrostatic Precipitation : Sturtevant Publication No. 7018. Paper covers, quarto size, 76 pages, illustrated. London : Sturtevant Engineering Co., Ltd.,

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

22,235 of 1957 (867,871). E. I. DU PONT DE NEMOURS AND CO. Preparation of elemental silicon.

28,769 of 1957 (867,583). H. B. CANNON. Slurry separating apparatus.

4,265 of 1958 (866,727). J. MULLER. Liquid-separation apparatus.

19,346 of 1958 (867,378). F. PATRMAN. Heavy-density sink-and-float installation.

118 of 1959 (866,646). BRITISH IRON AND STEEL RESEARCH ASSOCIATION. Processing of metallic ores.

1,733 of 1959 (867,254). METALLGESELLSCHAFT A.G. Heat economy in sintering apparatus.

11,436 of 1959 (867,948). CHAIN BELT CO. Separation of liquids or solids from a liquid.

42,495 of 1959 (868,560). NOVA BEAUCAGE MINES, LTD. Flotation process.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

Coal, Gasification : *Experiment, United States.* Underground Gasification of Coal : Preparing a Path by Hydraulic Fracturing. J. P. CAPP and others, *Rep. Inv. U.S. Bur. Min.*, 5808.

Costs, Mining : *Discussion, United States.* What the Mining Industry Can Do About Those Rising, Rising Costs. A. KNOERR, *Engg. Min. J.*, June, 1961.

***Gold, Australia :** *History, Western.* South Kalgurli. THE MINING MAGAZINE, July, 1961.

Production, Australia : *Industry, Beach-Sand.* Review of the Australian Beach Mining Industry. M. G. BAYLEY, *Queensland Gov. Min. J.*, Dec. 20, 1960.

Production, Canada : *History, B.C.* Historical Outline of B.C. Mining. W. H. WHITE, *Western Miner*, June, 1961.

Resources, Canada : *Exploration, Algoma.* Mineral Exploration of Algoma Central Railway Lands. D. E. SMITH, D. H. JAMES, *Western Miner*, June, 1961.

Geology

***Conglomerates, Auriferous :** *Origin, S. Africa.* The Witwatersrand Controversy. PAUL RAMDOHR, THE MINING MAGAZINE, July, 1961.

Economic, Canada : *Mineral, Nova Scotia.* Prospecting for Metallic Minerals in Mississippian Rocks of Cape Breton Island. D. G. KELLEY, *Canad. Min. J.*, June, 1961.

Economic, Hong Kong : *Iron, Leased Territories.* Mineralogy of the Ma On Shan Iron Mine. S. G. DAVIS, *Econ. Geol.*, May, 1961.

Economic, United States : *Mineral, Wyoming.* Geology and Mineral Deposits of the Carlile Quadrangle, Crook County. M. H. BERGENDAHL and others, *U.S. Geol. Surv. Bull.* 1082-J.

Geochemistry, Oils : *Content, Mineral.* Uranium and Other Metals in Crude Oils : Analysis, Distribution. *U.S. Geol. Surv. Bull.* 1100.

Gold, Africa : *Structure, Congo.* Relationships of General Structure to Gold Mineralization in the Kilo Area (Central Africa). R. WOODTLI, *Econ. Geol.*, May, 1961.

Palaeontology, Cretaceous : *Fossils, Micro.* An Annotated Bibliography of California Cretaceous Microfossils. Calif. Div. Mines. Special Report 66.

Properties, Rock : *Constants, Thermal.* A Heating Experiment to Determine the Thermal Constants of Rocks *in situ*. A. F. C. SHERRATT, F. B. HINSLEY, *Min. Engr.*, June, 1961.

Search, Ore : *Theories, Geological.* Geological Theory and the Search for Ore. R. L. STANTON, *Min. Chem. Engg. Rev.* (Melbourne), Apr. 15, 1961.

Sulphides, Ore : *Elements, Trace.* Trace Elements in Pyrite, Pyrrhotite, and Chalcopyrite of Different Ores. J. E. HAWLEY, I. NICHOL, *Econ. Geol.*, May, 1961.

Survey, Aerial : *Interpretation, Photogeological.* Photogeological Interpretation of Areas of Regional Metamorphism. J. A. E. ALLUM, *Bull. Instn. Min. Metall.*, June, 1961.

Survey, Geochemical : *Studies, United States.* Geochemical Studies in the Coeur d'Alene District, Idaho. V. C. KENNEDY, *U.S. Geol. Surv. Bull.* 1098-A.

***Survey, Geochemical :** *Tin, Copper.* Determination of Small Quantities of Tin and Copper. P. G. CURTIS, THE MINING MAGAZINE, July, 1961.

Metallurgy

Assay, Spectrochemical : *Minerals, Ores.* A Spectrochemical Method for the Semiquantitative Analysis of Rocks, Minerals, and Ores. A. T. MYERS and others. *U.S. Geol. Surv. Bull.* 1084-I.

†Electrolysis, Copper : *Handling, Slimes.* Handling Anode Slimes at Canadian Copper Refiners, Ltd. S. S. FORBES, *Canad. Min. Met. Bull.*, July, 1961.

Handling, Slurry : *Symposium, Canada.* Symposium on Slurries. *Canad. Min. Metall. Bull.*, May, 1961.

***Iron, Production :** *Reduction, Direct.* Iron Production Methods in Current Development. W. H. DENNIS, THE MINING MAGAZINE, July, 1961.

***Iron, Smelting :** *Blast-Furnace, United Kingdom.* New Blast Furnace at Millom. THE MINING MAGAZINE, July, 1960.

Steel, Open-Hearth : *Design, Open-Hearth.* Design and Operation of Open-Hearth Furnaces. F. BARTU, *Iron, Coal Tr. Rev.*, June 9, 1961.

Machines, Materials

Antimony, S. Africa : *Occurrence, Production.* Antimony. *Optima*, June, 1961.

Belting, Conveyor : *Use, Nylon.* Nylon in Conveyor Belting. K. W. ANDERSON, R. J. HARRISON, *Min. Engr.*, July, 1961.

***Blender, Powder :** *Uses, Mineral.* Blending Glassy Materials. A. E. WILLIAMS, THE MINING MAGAZINE, July, 1961.

Fans, Choice : *Discussion, Rhodesia.* Axial Flow or Centrifugal Fans. N. KONSOLAS, S. Rhod. *Chamber of Mines J.*, May, 1961.

Igniter Cord, Development : *Use, S. Africa.* The Development of Igniter Cord and Its Use in South Africa. S. G. BLETHYN, Univ. Birmingham *Min. Tech. Mag.*, 1961.

Steels, Drill : *Behaviour, Strain.* Strain Wave Behaviour in Percussive Drill Steels during Drilling Operations. I. HAWKES, P. K. CHAKRAVARIY, *Mine, Quarry Engg.*, July, 1961.

Structures, Welded : *Problems, Fatigue.* Fatigue : The Problem in Relation to Welded Structures. R. P. NEWMAN, *Welder*, Jan.–Mar., 1961.

Supports, Steel : *Arches, Yielding.* Usspurwies Yielding Roadway Supports. *Inform. Bull. N.C.B.* 61/226.

Mining

Communications, Underground : *Use, Radio.* Underground Radio Communication and Its Application for Use in Mine Emergencies. D. J. VERMUELEN, *Trans. S. Afr. Inst. Elec. Eng.*, Apr., 1961.

Costs, Review : *Trends, Current.* Cost Survey at Various Mining Operations. *Engg. Min. J.*, June, 1961.

Education, Great Britain : *Position, Review.* Mining Education. A. ROBERTS, *Coll. Guardian*, July 6, 1961.

General, Industry : *Computers, Uses.* Computers are the Answer : For better operational control, for greater accuracy, to speed calculations, to reach better decisions. A series of articles in the *Mining World* of San Francisco, for June, 1961.

General, S. Africa : *Methods, Review.* Modern Mining Practice—Part I. *Optima*, June, 1961.

General, Sweden : *Methods, Review.* Some Observations on Mining in Sweden. D. J. SMALL, *Mine, Quarry Engg.*, July, 1961.

General, United Kingdom : *Silica, Staffordshire.* Sand Preparation at Moneystone Quarry. *Mine, Quarry Engg.*, July, 1961.

Grades, Mine : *Use, Computer.* Electronic Computations of Open-Pit Tonnage and Ore Grade. R. L. WILSON, *Min. Engg.*, June, 1961.

Handling, Hoisting : *Engines, Mobile.* Mobile Winding Engines and Multi-Layer Rope Spooling. A. J. G. COULSTED, *Min. Engr.*, July, 1961.

Handling, Hydraulics : *Conduits, Applications.* Transportation of Solids in Conduits : Industrial Application Possibilities. E. CONDOLIUS and others, *Engg. J.* (Canad.), June, 1961.

Handling, Open-Pit : *Transport, Underground.* Transporting Open-Pit Production by Surface-Underground Haulage. E. P. PFLEIDER, C. A. DUFRESNE, *Min. Engg.*, June, 1961.

Hazards, Coal : *Dust, Explosibility.* Explosibility of Coal Dust in an Atmosphere Containing a Low Percentage of Methane. J. NAGY, W. M. PORTMAN, *Rep. Inv. U.S. Bur. Min.* 5815.

Hazards, Gas : *Drainage, Firedamp.* Drilling Equipment for Firedamp Drainage. *Inform. Bull. N.C.B.* 61/227.

Hydraulic, Coal : *Trials, United Kingdom.* Hydraulic Mining : Exploratory Trials in Mining Coal by a Water Jet at Trelewis Drift Mine. A. WRIGHT, *Min. Engr.*, July, 1961.

Hygiene, Silicosis : *Dust, Extraction.* Ventilation and Dust Extraction Systems with the Joy Continuous Miners at Easington Colliery. R. ROBINSON, *Min. Engr.*, June, 1961.

†**Reserves, Ore :** *Grade, Cut-Off.* Marginal Analysis : Its Application in Determining Cut-Off Grade. E. L. VICKERS, *Min. Engg.*, June, 1961.

Rising, Mechanical : *System, Canada.* Raising at Beaverlodge. W. H. GRIFFIN, *Canad. Min. J.*, June, 1961.

Support, Ground : *Conditions, "Moving."* Ground Support at the Pitch Mine, Colorado. J. E. DUNN, *Min. Engg.*, June, 1961.

Support, Ground : *Filling, United Kingdom.* Underground Staving and Dirt Bunkering at Holditch Colliery. F. STEPHENS, *Iron, Coal Tr. Rev.*, June 16, 1961.

Support, Ground : *Units, Powered.* The G.H.H. Powered Supports. D. M. H. REVILL and others, *Coll. Guardian*, July 6, 1961.

Support, Roof : *Equipment, Choice.* General Remarks on Roof Supports in Roadways. *Rev l'Ind. Miner.*, Special Issue SIM B2.

Ore-Dressing

Comminution, Grinding : *Mill, Aerofall.* Sand Preparation at Moneystone Quarry. *Mine, Quarry Engg.*, July, 1961.

Concentration, Jigging : *Rôle, Modern.* The Rôle of Jigs in Modern Ore Dressing. F. A. WILLIAMS, *J. S. Afr. Inst. Min. Metall.*, May, 1961.

General, Tin : *Concentrator, S. Africa.* The Treatment of Tin Ores in the Rooiberg Concentrator. R. C. M. VAN DER SPUY. *J. S. Afr. Inst. Min. Metall.*, May, 1961.

General, United States : *Lead-Zinc, Idaho.* Bunker Hill's Concentrator : Equipped to Process 3,000 tons of Lead-Zinc Ore Daily. N. J. SATHER, *Min. Engg.*, June, 1961.